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GUIDE FOR EVALUATING CAPACITY, MANAGEMENT, OPERATION AND MAINTENANCE PROGRAMS FOR SANITARY SEWER COLLECTION SYSTEMS

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CHAPTER 1. INTRODUCTION

1.1 Overview

Sanitary sewer collection systems are designed to remove wastewater from homes and other buildings and convey it to a proper treatment facility and disposal location. The wastewater collection system is a critical element in the successful performance of the wastewater treatment process. EPA estimates that collection systems in the U.S. have a replacement value of $1 to $2 trillion. Under certain conditions, poorly designed, built, managed, operated, and/or maintained systems can pose risks to public health, the environment, or both. These risks arise from sanitary sewer overflows ("SSOs") in the collection system or by compromised performance of the wastewater treatment plant. Effective and continuous management, operation, and maintenance, as well as ensuring adequate capacity and rehabilitation when necessary, are critical to maintaining collection system capacity and performance while extending the life of the system.

However, the current performance of many collection systems is poor. Contributing to this problem is the fact that many collection systems have received minimal maintenance for many years. This lack of effort has resulted in deteriorated sewers with subsequent overflows, cave-ins, hydraulic overloads at treatment plants, and other safety, health, and environmental problems. As one of the most serious and environmentally threatening problems, sanitary sewer overflows are a frequent cause of water quality violations and are a threat to public health and the environment. Beach closings, flooded basements, closed shellfish beds and overloaded wastewater treatment plants are some symptoms of collection systems with inadequate capacity and improper management, operations, and maintenance. These problems create the need for both the collection system authority and the regulatory compliance authority to conduct more thorough evaluations of sanitary sewer collection systems.

1.2 Purpose of CMOM Programs

The purpose of capacity, management, operation, and maintenance ("CMOM") programs is to optimize labor, materials, money, and equipment. In other words, the goal of such programs is to manage the system's human and material resources as effectively as possible while achieving regulatory compliance and delivering a high level of service to customers. The benefits of a CMOM program include:

- Ensuring the availability of facilities and equipment as intended. This means that the conveyance capacity of the collection system is maintained as originally designed. Managers of a good CMOM program will also plan for changes in capacity needs and react accordingly, before problems occur.

- Maintaining the reliability of the equipment and facilities as designed. Collection systems are required to convey raw wastewater 24 hours per day, 7 days per week, 365 days per year. Reliability is a critical component of the operation and maintenance program, if facilities and operators are not reliable, then performance of the collection system to operate as designed is impaired.

- Maintaining the value of the investment. Collection systems represent major capital investments for communities and are one of the communities' major capital assets. If a CMOM program is not in place, equipment and facilities will deteriorate through normal use and age. Maintaining the value of the capital asset is a major goal of the CMOM program. This will result in the need for ongoing investment to ensure design capacity while maintaining existing facilities and equipment and also extending the life of the system.

The performance of wastewater collection systems clearly is directly linked to the effectiveness of the CMOM program for the system. Frequent stoppages in the system that result in overflows and backups are performance characteristics of a system that has an inadequate CMOM program that has failed to maintain the capacity of the system. Other major performance indicators include pump station reliability and equipment availability and avoidance of catastrophic system failures such as collapsed pipe.

In effect, a CMOM program is what a collection system authority uses to manage its assets, in this case, the collection system itself. The CMOM program is comprised of a set of best practices that have been developed by the industry and are applied over the entire life cycle of the collection system and include:

- Design and construct for O&M
- Know what is in the system (inventory and physical attributes)
- Know where it is at (maps and location)
- Know what condition it is in (assessment)
- Plan and schedule work based on condition and performance
- Repair, replace, rehabilitate based on condition and performance.

1.3 NPDES Regulatory Compliance

EPA and state NPDES compliance inspectors evaluate collection systems and treatment plants, in part, to determine compliance with permit conditions regarding proper operation and maintenance. These permit conditions are based on current regulatory language at 40 CFR 122.41(e) which states that: "The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit." Additionally, some permits may contain language explicitly prohibiting unpermitted discharges including dry weather overflows. Poor operation and maintenance practices frequently lead to unpermitted discharges.

Until recently, the only guidance for inspectors making determinations regarding compliance with the requirement for proper operation and maintenance is provided in one portion of the *NPDES Compliance Inspection Manual* (September 1994, EPA Doc. No. 300-B-09-014). *Evaluating CMOM Programs for Sanitary Sewer Collection Systems* is designed to complement and enhance the current information available to inspectors who evaluate systems for evidence of proper O&M.

By reviewing this document, the regulated community can also become familiar on the criteria used by regulatory compliance inspectors in making these determinations. Collection system authorities can audit their own systems against the checklists in Chapter 3 to determine whether they follow the recommended practices and address any discrepancies as needed in order to reduce the possibility for SSOs and improve or maintain compliance.

1.4 Purpose of This Guide

The purpose of this guide is to serve as a supplement to EPA's NPDES Inspection Manual and provide compliance monitoring inspectors with additional information and insight that will help them determine whether a CMOM program is adequate for a specific collection system. Auditors should use the checklist in Chapter 3 as the primary tool for questions during the paperwork review portion of the audit and/or onsite evaluation. Auditors are strongly encouraged to review the guidance portion of this document prior to conducting audits. The guidance provides a background for the information in the checklist and is a good reference document.

1.5 EPA's Proposed CMOM Program

In the future, CMOM will be an regulatory requirement for municipal NPDES permittees. EPA is currently working to propose an NPDES regulation for municipal sanitary sewer collection systems and the control of sanitary sewer overflows (SSOs). The proposed regulation has three major provisions related to controlling SSOs:

- ***Standard permit conditions***. Standard permit conditions will address:

    - Recordkeeping and reporting requirements for SSOs
    - Public notification requirements for SSOs
    - Capacity assurance, management, operation, and maintenance requirements for municipal sanitary sewer collection systems
    - Prohibition of SSO discharges to waters of the United States.

- ***Municipal satellite collection systems***. The regulation addresses the need for satellite systems to obtain NPDES permit coverage. Satellite systems are collection systems that do not treat and discharge their wastewater. Rather, they convey flows to a treatment facility where the NPDES permittee is a different municipal entity.

- ***Emergency overflow structures***. The regulation provides criteria for evaluating the location of constructed emergency overflow structures for collection systems.

Once final, this regulation is likely to establish NPDES permit conditions requiring capacity assurance, management, operation, and maintenance (CMOM) programs for systems to be developed, implemented and periodically audited. Since the (draft) proposed rule addresses CMOM self-auditing requirements, facilities may want to use the guidance in this document to familiarize themselves with the areas future audits may entail under the rule and gain some experience with CMOM.

1.6 Region 4 MOM Program

EPA's Office of Compliance coordinated with EPA Region 4 on development of this document. Region 4 created the "Publically-Owned Treatment Works MOM Programs Project" under which the region asks permitted wastewater utilities, and any associated satellite utilities, to perform a detailed audit of the management, operation, and maintenance (MOM) programs associated with their facilities. Participants provide a report which includes the audit results, any improvements that can be made, and any schedules necessary to make those improvements. By self-disclosing any needed improvements, the participants can be eligible for significantly less civil penalties while under a remediation schedule.

This guidance is based mainly on the Region 4 MOM Audit Program. However it is also intended to provide flexibility for NPDES compliance programs with limited resources for conducting audits. Therefore, some of the more specific items of the Region 4 program have been omitted in order to provide a more streamlined inspection framework. The fundamental concepts behind CMOM have been maintained in this
document.

By drawing on the most important elements of the region's program in addition to existing NPDES inspection guidance and the field expertise in NPDES compliance monitoring, the CMOM guidance provides a comprehensive framework for inspectors and the regulated community alike in determining whether operations and maintenance throughout the POTW are being appropriately executed.

1.7 Who Should Read This Guide?

Although the primary audience for this document is composed of EPA and state compliance monitoring inspectors, the guidance is also intended for use by the regulated community – utilities, collection system managers, wastewater authorities, as well as consultants or third-party compliance auditors. The audience is not limited to municipal facilities – industrial wastewater treatment system managers can also apply the information in these guides to their facilities.

In short, the guidance provided in this document is applicable to small, medium, and large systems; both publicly and privately owned systems; and both regional and satellite collection systems.

Regardless of size, each utility will have systems and practices unique to its collection system. While these specific characteristics will vary among systems, the CMOM concepts and best practices will apply to all. Where appropriate, this document provides guidance on the differences.

Because the guide provides a framework for evaluation of the system, it may provide the regulated community an understanding of the expectations of the NPDES authority as it assesses the adequacy of programs that address capacity, management, operations, and maintenance.

1.8 How to Use the Guide

The guide and checklist support a three-tiered approach to the CMOM audit:

- Overall evaluation of the CMOM program based on interviews with management and field personnel and observation of routine activities and functions

- Review of pertinent information and data contained in records and information management systems

- Evaluation based on field/site inspections.

Chapters 2 and 3 of this document present detailed information on conducting audits of collection systems. Chapter 3 contains the comprehensive audit checklist and is supported by the information provided in Chapter 2. Both chapters present and discuss the CMOM concepts and programs in terms of the collection system inspection or audit. Where possible, we have presented real-world examples designed to provide auditors an insight into what they may see while conducting an actual audit. Chapter 2 provides a break-down and overview of each CMOM concept and what to look for when evaluating the system. Chapter 2 essentially defines the CMOM elements for the auditor. It then follows through with a discussion of the indicators or other clues the auditor should be aware of. The appendices also present additional information taken from industry manuals and other references.

We cannot over-stress the importance of the "one size does not fit all" approach to evaluating CMOM programs. The principles covered in this guidance are advisable to all wastewater collection systems however, they may be implemented through different means depending on the system. In some occasional cases, a CMOM feature may not be implemented at all, due to characteristics of the system. An auditor should be able to look at the system as a whole and determine whether certain key elements should be or are present and to what extent the system incorporates a CMOM principle. Generally, when facilities adequately practice the principles laid out in this guidance, they will experience fewer overflows and therefore fewer instances of noncompliance.

Auditors will also find that the location or names of some documents, logs, or reports may vary from facility to facility. The guidance tries to provide a general description of the materials the auditor should request. Facilities may differ with regard to exactly what they call a particular document or where it is stored.

For regulatory compliance inspectors who visit a facility more than once, it may not be necessary to go over certain CMOM elements at each visit. For instance, while it would be valuable for the inspector to closely study system design documents initially, a less detailed evaluation may be sufficient in subsequent visits to the same facility.

1.9 Terminology

The term "audit" is used most frequently in this document in lieu of "inspection." Since "inspection" generally refers to an evaluation conducted by the NPDES regulatory authority, "audit" is used to capture the wider universe of evaluations (e.g., those conducted by the facility itself or by a third-party auditor).

Similarly, the term used to describe the person conducting the CMOM evaluation or audit is "auditor" -- this could be either the state or EPA NPDES compliance inspector, someone from the sewer collection system authority, or an external or third-party auditor hired to evaluated the system.

Throughout the guide we refer to the regulated NPDES permittee/collection system as the "utility," the "regulated entity," the "sewer collection system agency, " or the sewer "authority." Most often, the term "authority" is used and refers to the group of individuals responsible for the administration and oversight of the sewer system and its associated staff (in either a municipal or industrial context); capacity evaluation, management, operation, and maintenance, programs; equipment; and facilities. The term "facility" is used to refer to the actual objects that make up the components of the collection system (e.g., pump stations, yards, storage areas, office space where records are maintained).

1CHAPTER 2. COLLECTION SYSTEM CAPACITY, MANAGEMENT, OPERATION, AND MAINTENANCE PROGRAMS

EPA's Office of Compliance has prepared the "Guide for Evaluating CMOM Programs at Sanitary Sewer Collection Systems" to support inspection personnel in conducting assessments of CMOM programs. Utilities will also find this guide useful for the purpose of conducting self-audits or evaluations of their programs. The basic goal in conducting a CMOM assessment is to gather information about the facility that will provide the auditor with a well-informed understanding of the capacity, performance, and therefore the compliance status of the facility. Conducting such an assessment will help to:

1. Identify and document SSOs
2. Identify potential SSOs due to capacity limitations
3. Identify potential SSOs due to failure to maintain.

This manual has been prepared to assist auditors in achieving this goal by presenting a framework for the assessment and providing the auditor with technical guidance. The Guide assumes that the auditor will have a working knowledge of collection systems, the NPDES program, and, in the case of state and EPA compliance inspectors, experience conducting inspections.

This chapter provides an overview of the CMOM program elements. The information presented will help an auditor evaluate wastewater collection system operation and maintenance procedures. The key elements of the CMOM program, which are presented in detail in the following sections, include:

- Collection System Management
- Collection System Operation
- Collection System Maintenance
- Sewer System Capacity Evaluation.

For EPA and State inspectors, conducting an evaluation of collection system CMOM programs shares many similarities with other types of compliance inspections. Overall, the auditor will review records, interview authority staff and conduct field inspections, generally in that order although tailored, if necessary, to meet site-specific needs. Prior to performing the on-site interviews and inspections, preliminary information may be requested that will provide the inspection team with an overall understanding of the organization and the CMOM programs. This information may be reviewed before the onsite activities are conducted to allow for a more focused approach to the inspection. This information also provides a basis for more detailed data gathering during on site activities. Examples of information typically requested prior to the inspection may include collection system master plans, capital improvement projects (CIP) plans, emergency response plans, recent SSES reports, engineering studies and the training plan. Depending on how much information is needed, the collection system authority may need ample lead time to gather and copy these documents. Alternatively, the auditor may offer to review the documents and bring them back when doing the onsite inspection so that extra copies are not necessary. No matter which method is used, the importance of up-front preparation cannot be overemphasized. With the exception of pump stations and manholes, much of the collection system is not visible. Therefore, the more complete the auditor's understanding of the system is prior to the assessment, the more successful the assessment will be.

The auditor will then proceed with the onsite activities. Guidance for conducting compliance inspections exists in the form of the September 1994 NPDES Compliance Inspection Manual (EPA 300-B-94-014). The Manual provides the general procedures for performing compliance inspections and is a valuable source of information on such topics as entry, legal authority and responsibilities of the inspector. Although CMOM evaluations are not specifically addressed in the manual, the general inspection procedures can be applied to CMOM inspections. Another good reference for general inspection information is the Multi-Media Inspection Manual, NEIC, March 1992, (EPA-330/9-89-003-R). However, there are some issues with entry that are specific to CMOM inspections. The auditor should be aware that some collection system components may be on private property and they must gain entry properly through the property owner.

During the opening conference, the auditor should establish an agenda for record review, staff interview, and field inspections. It is important for the authority to know what type of information the auditor is seeking so that it can be provided in a timely and efficient manner. Therefore, the auditor might request these documents in advance of the inspection or at the opening conference. Listed below are some of the records, plans and other documents that an auditor might expect to review in a CMOM inspection.

Documents to Review Include:

• Organization chart(s) • Staffing Plans • Job descriptions • Sewer Use Ordinance • Overall map of system showing facilities such as pump stations, treatment plants, major gravity sewers, and force mains • O&M budget with cost centers for wastewater collection • Performance measures for inspection, cleaning, repair, rehabilitation • Recent annual report if available • Routine reports regarding system O&M activities	• Collection system master plan • Capital improvement projects (CIP) plan • POTW Flow Records • Safety manual • Emergency response plan • Management Policies and Procedures • Detailed maps/schematics of the collection system and pump stations • Work order management system • O&M manuals • Materials management program • Vehicle management • Procurement process • Training plan

The above list is not all inclusive. The *Wastewater Collection System Audit Data Form*, included as Appendix A, provides examples of the types of information an auditor should attempt to obtain while onsite.

A schedule should be established by the inspection team for the staff interviews and field assessments. Interviews are generally conducted with line managers and supervisors who are responsible for the various O&M activities and support services staff from engineering, construction, human resources, and purchasing, where appropriate. Appendix B presents an example agenda and schedule that would be used for a large authority. Authority size and the system's physical characteristics will determine the length of time needed for the inspection. A guideline for the time required, given a two person inspection team, would be two days in the smallest town, and a week or more for large systems.

Field inspections are typically conducted after interviews. The following is a list of typical field sites the team should inspect:

- Mechanical and electrical maintenance shops
- Fleet maintenance (vehicles and other rolling stock)
- Materials management; warehouse, outside storage yards
- Field maintenance equipment; crew trucks, mechanical and hydraulic cleaning equipment, construction and repair equipment, and television inspection equipment
- Safety equipment
- Pump stations of several types and sizes
- Dispatch and SCADA systems
- Crew facilities
- Training facilities
- Chemical application equipment and chemical storage area (use of chemicals for root and grease control, hydrogen sulfide control [odors, corrosion])

- Where applicable, sanitary sewer overflows
- A small, but representative, sampling of manholes
- The POTW to observe influent characteristics and flow records.

The auditor is reminded to take appropriate safety precautions. Collection systems may present physical, biological, chemical and atmospheric hazards. Safety equipment should include a hard hat, steel-toed boots, safety glasses, gloves and for those with prescription eyeglasses, eyeglass straps are very important. A flashlight is also useful for collection system inspections.

Collection system operators typically deal with manhole cover removal and other physical activities. The auditor should refrain from entering confined spaces. A confined space is defined by the Occupational Safety and Health Administration to mean a space that: (1) Is large enough and so configured that an employee can bodily enter and perform assigned work; and (2) Has limited or restricted means for entry or exit; and (3) Is not designed for continuous employee occupancy. A "permit-required confined space (permit space)" means a confined space that has one or more of the following characteristics: (1) Contains or has a potential to contain a hazardous atmosphere; (2) Contains a material that has the potential for engulfing an entrant; (3) Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or (4) Contains any other recognized serious safety or health hazard.

OSHA has promulgated standards for confined spaces, however, these do not apply directly to municipalities, except in those states that have approved plans and have asserted jurisdiction under Section 18 of the OSHA Act. Contract operators and private facilities do have to comply with the OSHA requirements and the auditor may find that some municipalities do so on their own. In sewer collection systems, the two most common confined spaces are the underground pumping station, and manholes. The underground pumping station is typically entered through a relatively narrow metal or concrete shaft via a fixed ladder. Auditors conducting the field evaluation component of the CMOM audit should be able to identify and avoid permit-required confined spaces. Confined spaces may have signage posted near their entry containing the following language:

DANGER–PERMIT REQUIRED–CONFINED SPACE
AUTHORIZED ENTRANTS ONLY

If confined space entry is absolutely necessary, auditors should consult with the utility first, have appropriate training on confined space entry, and use the proper hazard detection and personal safety equipment. More information on confined space entry can be found in “Operation and Maintenance of Wastewater Collection Systems,” California State University, Sacramento (Phone number: 916-278-6142).

However, most confined spaces the auditor will encounter in collection system inspections will be unmarked.

2.1 Management Program

The collection system management program is the backbone for operation and maintenance activities. The purpose of the management program is to promote responsible and effective collection system operations and maintenance. The goals of a management program should include:

- Protection of the public health and prevention of unnecessary property damage.
- Minimization of infiltration, inflow and exfiltration and maximum conveyance of wastewater to the wastewater treatment plant.
- Provision of prompt response to service interruptions.
- Use of allocated funds efficiently.
- Identifying and remedying design, construction and operational deficiencies.
- Performance of all activities in a safe manner so as to avoid injuries.

Without the proper policies, procedures, management and training systems, operation and maintenance activities may lack organization and precision, resulting in potential risk to human health and environmental contamination of surrounding water bodies, lands, dwellings, or groundwater. The following sections discuss the elements of a collection system management program.

Management Documents to Review

- Organization chart(s)
- Staffing Plans – Number of people and classifications
- Job descriptions for each classification
- Sewer Use Ordinance
- Safety manual
- Training Program documentation.

2.1.1 Organizational Structure

An important component of a collection system authority's CMOM program is the system's organizational structure. This information may take the form of an organizational chart or narrative description of roles and responsibilities, or both. There is no single model for how an organization should be structured. However, regardless of the specific organizational structure, authority for CMOM activities and roles and responsibilities should be clearly defined, documented, and communicated. In looking at the organizational chart, the auditor should look for the following:

- In general, no one individual should have more than seven individuals reporting directly to him or her. The seven individuals may have more people reporting to them. This prevents the top managers from having to track too many individuals.

- Operations and maintenance staff should ideally each report to the same manager or director, except in very small systems. The manager or director should have overall collection system responsibility.

- In some systems, maintenance may be carried out by a city-wide maintenance organization, which may also be responsible for such diverse activities as road repair and maintenance of the water distribution system. This can be an effective approach, but only if adequate lines of responsibility and communication with other areas of the collection system are established.

In a properly implemented program, staff and management should be able to articulate their job/position responsibilities.

The operation and maintenance of wastewater collection systems is a demanding and exacting occupation. It requires personnel with the technical know-how and competence to provide all the services to every aspect of the collection system. Personnel must be trained to deal with constantly changing situations and requirements, both regulatory and operational. For each job/position, the following types of information should be included:

- Nature of the work to be performed
- Examples of the types of work
- Minimum requirements for the position
- Desirable experience and training
- Necessary special qualifications (e.g., certifications).

The inclusion of job descriptions as part of the organizational program helps ensure that all employees know their specific job responsibilities and have the proper credentials to be hired for the job. An auditor should look for indications that responsibilities are communicated to employees. Such indications may include training programs, meetings between management and staff, or policies and procedures. In addition to reviewing documentation of these items, it is useful in the course of interviews with staff to discuss staff management. The auditor should note whether staff receive a satisfactory explanation of their job descriptions and responsibilities. In addition, when evaluating the CMOM program, job descriptions will help an auditor determine who should be interviewed and who has specific responsibilities.

The system's personnel requirements vary in relation to the overall size and complexity of the collection system. They will also depend upon the collection system operators' other responsibilities. In very small systems these responsibilities may include operation of the wastewater treatment plant as well as the collection system. In many systems, collection system personnel are responsible for the storm water as well as wastewater collection system. References providing staff guidelines or recommendations are available to help the auditor determine if staffing is adequate for the facility being inspected. These references include:

- Manpower Requirements for Wastewater Collection Systems in Cities of 150,000 to 500,000 Population, USEPA. March 1974, (PB95157442)
- Manpower Requirements for Wastewater Collection Systems in Cities and Towns of up to 150,000 Population, USEPA. March 1974, (PB227039)
- Operation and maintenance of Wastewater Collection Systems, Volume II, California State University, 1995.

The following tables have been taken from the EPA documents listed above to provide the auditor with guidance on staffing requirements. However, the auditor should note the age of these documents and take into account technological advances that have occurred since the time of their publication that might reduce staffing requirements. For instance, the advance of telemetering equipment such as "SCADA" has likely reduced the number of field inspection staff needed for systems with several pump stations. Other system-specific characteristics should also be accounted for when using these tables. An example of this might be collection systems that are not primarily constructed of brick. Those systems do not require the number of masons the tables specify.

STAFF COMPLEMENTS FOR WASTEWATER COLLECTION SYSTEM MAINTENANCE POPULATION SIZE

Occupational Title	5,000		10,000		25,000		50,000		100,000	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Superintendent	1	5	1	10	1	20	1	40	1	40
Asst. Superint.										
Maint. Supervisor							1	40	2	80
Foreman	1	15	1	20	1	20	1	40	1	40
Maint. Man II	1	15	1	20	1	20	1	40	1	40
Maint. Man I	1	15	1	20	2	60	3	120	5	200
Mason II							1	40	1	40
Mason I									1	40
Maint. Eq. Op.					1	40	2	80	3	120
Const. Eq. Op.	1	15	1	20	1	20	1	40	1	40
Auto. Eq. Op.									1	40
Photo. Insp. Tech.									1	40
Laborer	1	15	1	20	2	40	2	80	5	200
Dispatcher							1	40	2	80
Clerk Typist							1	20	1	20
Stock Clerk							1	40	1	40
Sewer Maint. Staff	6	80	6	110	9	220	16	620	27	1060
M. Mech. II (c)										
M. Mech. I (d)										
M. Mech Help. (d)										
Const. Insp. (e)(f)										
Total Staff										

(a) Estimated number of personnel.
(b) Estimated total man-hours per week.
(c) Multiply number of lift stations maintained by 8/3.
(d) Multiply number of lift station visits per week by 1.
(e) Multiply estimated construction site visits per week by 8/3.
(f) Determined by the number of Construction Inspectors employed and developed on a judgmental basis.

Unit processes included in this Staffing Table are:

1. Maintenance of Sanitary sewer main lines & appurtenances (laterals are not included).
2. Maintenance of Storm sewer main lines.
3. Maintenance of lift stations.
4. Inspection of newly constructed sewer main lines and appurtenances.

STAFF COMPLEMENTS FOR WASTEWATER COLLECTION SYSTEM MAINTENANCE
(Estimated Number of Personnel)
POPULATION SIZE

Occupational Title	150,000	200,000	300,000	400,000	500,000
Superintendent	1	1	1	1	1
Assistant Superintendent	1	1	1	1	1
Maintenance Supervisor II	1	1	1	1	1
Maintenance Supervisor I	1	2	2	3	3
Equipment Supervisor	1	1	1	1	1
TV Technician II	1	2	2	3	3
TV Technician I	1	2	2	3	3
Foreman	2	3	4	5	6
Maintenance Man II	3	5	6	8	9
Maintenance Man I	11	17	22	29	33
Mason II	1	2	2	3	3
Mason I	1	2	2	3	3
Maint. Equipment Operator	6	8	12	15	18
Const. Equipment Operator	3	4	6	8	9
Auto. Equipment Operator	2	3	4	5	6
Laborer	7	10	14	18	22
Dispatcher	2	2	2	3	3
Stock Clerk	1	2	2	3	3
Clerk Typist	2	2	2	3	3
Sewer Maintenance Staff	48	70	88	116	131
Maintenance Mechanic II (a)					
Maintenance Mechanic I (b)					
Maint. Mechanic Helper (b)					
Electrician (c)					
Const. Inspector Super. (d)					
Construction Inspector (e)					
Total Staff					

(a) Divide number of lift stations maintained by 15.
(b) Divide number of lift station visits per week by 40
(c) Divide number of lift stations maintained by 15.
(d) Determined by the number of Construction Inspectors employed and developed on a judgmental basis.
(e) Divide estimated daily construction site visits by 2.

Unit Processes included in this Staffing Table are:

1. Maintenance of sanitary sewer main lines and appurtenances (lateral lines are not included)
2. Maintenance of storm main lines
3. Maintenance of lift stations
4. Inspection of newly constructed main lines and appurtenances.

The auditor may want to note the turnover rate and current levels of staffing, i.e. how many vacant positions exist and for how long they have been vacant. This may provide some indication of potential understaffing, which can create response problems.

Most preventive maintenance tasks can be performed by collection system personnel, even if they lack formal training. However, some preventive and corrective maintenance will require special training. Often, collection system equipment needs to be repaired quickly. However, using unqualified personnel risks serious injury, warranties may be nullified if repairs are not done properly by trained people, collection system components and private property may be damaged, citizens endangered and SSOs may result from their activities. Auditors should review specific qualifications of personnel and determine if the tasks designated to individuals, crews, or teams match the job descriptions and training requirements spelled out in the organization program. From an evaluation standpoint, the auditor might try to determine what type of work is performed by outside contractors and what specific work is reserved for collection system personnel. If much of the work is contracted, it is appropriate to review the contract, and to look at the contractor's capabilities. If the contractor handles emergency response, the auditor should review the contract with the authority to determine if the emergency response procedures and requirements are outlined.

2.1.2 Training

The commitment of management is key to a successful training program. The utility should arrange for the presentation for training programs in order to demonstrate management support for the work needed. Resources in the form of funding must be invested in the program for it to be productive. A guideline for the typical amount of funding for training is 3-5 % of the authority's gross budget. However, in very large authorities or those undergoing a lot of construction work this percentage may be considerably lower. It should be noted that although training is not explicitly required under current regulations, an authority with untrained or poorly trained collection system operators runs significantly more risk of experiencing non-compliance in the collection system. The following elements are essential to an effectively run training program:

- The program should have clearly defined goals and objectives and a detailed action plan with the necessary funding to carry it out.

- The program should have a formal feedback and participation program to open the lines of communication between all participants.

- The program should include a training committee which develops training program goals and objectives.

- The program should be innovative and geared to the specific needs of the collection system.

The authority should generally provide training in the following areas:

- Safety.
- Confined Space Entry - Every system should also have a strict policy and permit program.
- Routine line maintenance - May be on-the-job (OTJ) training only.
- Pump Station Operations and Maintenance.
- Electrical and instrumentation - May be a combination of formal and OTJ training (note that for safety reasons many systems limit their in-house electrical tasks unless they employ licensed and experienced, high voltage staff).
- SSO/Emergency Response - All field staff should be trained.
- Traffic Control (where applicable).
- Record keeping.
- Public Relations.

Auditors should be aware that personnel job descriptions often contain training requirements. The responsibility rests with the collection system to define those training requirements (based on equipment, process, regulatory, or health and safety needs). The auditor should determine from the available records and employee interviews whether the training requirements in the jobs' descriptions are being met. If they are not being met, the auditor might attempt to determine the underlying cause, e.g., lack of management support, lack of resource allocation , etc.

The training program should identify the types of training required and offered. Types of training vary, but may include general environmental awareness training, training related to specific equipment, training on policies and procedures, and training on conducting maintenance activities. Training opportunities are available from a multitude of sources, including community colleges or vocational schools, correspondence schools, industry seminars, courses offered by manufacturers, workshops offered by state and federal authorities, and operator exchanges. If the authority is carrying out its own training the

Sources of Training

Training is required to safely perform inspections, follow replacement procedures, and lubricate and clean parts and equipment. There are many sources of maintenance training:

- Manufacturer training
- In-house training
- On-the-job (OTJ) training
- Industry-wide training (e.g., consultants, regulatory authorities, professional associations, educational institutions).

auditor should review one or more examples of training materials to answer the following questions; Are the materials appropriate to the training topic and the level of those being trained? Are they likely to accomplish the intended goal? The auditor should consider whether, after reviewing a pump maintenance module, he/she could carry out the task. If the answer is yes, it may be a good training program. Also, the auditor should solicit operator opinions on the training they receive.

The authority should routinely assess the effectiveness of training through periodic testing, drills, demonstrations, or informal reviews, and improve training based on this assessment. Do they field a maintenance team at the local Water Environment Federation "Operator's Challenge?" Auditors can evaluate training by reviewing certain aspects of collection system performance that are directly impacted by the effectiveness of the training program. For example, suppose there has been an increase in the number of personnel injuries, or perhaps an increase in complaints from citizens. These types of incidences are a possible indication that training deficiencies may exist.

It is important that employee participation in training programs is tracked. Information that should be tracked for each employee includes:

- Employee identification and title.
- Employee certifications/licenses.
- Classes attended.
- Test results, if applicable.
- Continuing education credits awarded.

2.1.3 Communication

Communication is essential to ensuring collection systems run efficiently and effectively. The collection system authority should be able to describe procedures for both internal communication and external communication. External communication may consist of outreach/public education and customer service. Internal communication may consist of meetings, newsletters, and performance reviews. E-mail and wireless can be important tools for day-to-day, real-time communication.

It is especially important that an effective communication link exists between wastewater treatment plant operating crews and collection system crews. This link is critical to ensure optimization of treatment plant operations, such as accommodating high flows or other conditions that may stress treatment processes. In smaller communities, the individuals who operate the treatment plant may also operate and maintain the collection system. Ideally, the auditor wants to look for both formal, routine communication (i.e. daily, weekly or monthly meetings, regular memos or reports) as well as informal, real-time lines of communication.

The auditor should attempt to determine the lines or mechanisms of internal communication within the collection system to ensure all employees receive information and have an appropriate forum to provide feedback. The auditor should assess the level of communication at the facility by interviewing several levels of staff or by simply observing the collection system teams on work assignments. The collection system authority should have procedures and be able to demonstrate internal communication between the various levels and functions of the facility regarding its management, operations, and maintenance programs.

Effective internal communication requires flow both from the top down as well as from the bottom up. Top-down communication can be through bulletin board posters, paycheck inserts, regular staff meetings, electronic mail or informal brown-bag lunch discussions. Bottom-up communication may include establishment of environmental committees, confidential hotlines, electronic mail, or direct open discussion. Managers may also offer incentives to employees for performance, and encourage them to submit suggestions for ways to improve the performance of the collection system. Since employees are on the "front lines," they are often an excellent source of ideas, issues, and information about what is going on at the work site. In this context, the auditor can check for morale-boosting activities or reward programs, such as "employee of the month" and "operator of the year."

2.1.4 Customer Service

A critical aspect of external communication is customer service. The customer service program should have in place a system to record all incoming inquiries, service requests, or complaints and procedures for assigning those inquiries, requests, or complaints to the responsible individuals. The procedure should ensure that all relevant information is recorded concerning the inquiry, complaint or request. The auditor should review a selection of customer complaint records, looking for the following:

- Personnel who received the complaint;
- Date of the inquiry, complaint or request
- Nature of the inquiry, complaint or request
- Location of the problem
- To whom the follow-up action was assigned
- Date the follow-up action was assigned
- Date the inquiry, complaint or request was resolved.

This system, whether electronic or paper, (for all but the smallest systems this function should be electronic) will allow the collection system to ensure it addresses all incoming inquiries, requests, and complaints. From this, managers can either develop or change programs to better address the areas of issue/concern.

To fully understand the context of customer inquiries, requests, and complaints, an auditor should understand the history, topography, boundaries, and demographics of the collection system's jurisdiction before site evaluations are conducted. Awareness of past issues, population served, compliance history, and other elements will help an auditor determine whether the amount and types of inquiries, requests, and complaints are increasing or decreasing. For example, there may have been many complaints during a certain week. The auditor can examine records from that week to determine if there was a specific event, e.g., a large precipitation event, that caused the increase in inquiries.

Staff who answer customer complaints, inquiries, or requests should be provided with sample correspondence or "scripts" to help guide them through written or oral responses. The auditor should look for procedures on how to answer the telephone, e-mail, and other communication used by personnel. An auditor may evaluate staff telephone responses by looking at the number of persons available to answer calls, the number of repeat callers, average length of calls, and/or volume of calls per day.

Collection system operators and their activities are the most visible segment of any wastewater treatment organization. Workers project a public image for their utilities on city and town streets. For this reason, personnel need to be trained in what to expect in public situations. For example, collection system managers should be familiar with the areas around public rights-of-way and easements to which their crews must gain access to service facilities. Managers and crew leaders should know how to deal with the public when approached. In particular, evaluate procedures for working in streets and rights-of-ways. Methods for minimization of public impact and protection of public safety should be evident.

The external appearance of collection systems crews in the field influences the public's confidence in the authority or private utility. Auditors can observe if uniforms are provided for crewmen, and whether vehicles and equipment are kept in good working order and appearance. Vehicles should be equipped with adequate emergency lighting and flashers, traffic control signs and barriers, etc. A well-disciplined crew not only projects favorably to the public, but also serves to improve employee morale. In essence, if the public is satisfied by positive images they see in the field, this can only help when the authority approaches the public regarding rate increases. Before collection system service or repair activities begin, managers should provide the public written notices, pamphlets, or information sheets that explain forthcoming activities.

It is important for wastewater managers to note that the community often knows very little about the wastewater treatment and collection industry. The community may only be aware of the industry or local authority through articles or in local newspapers, and subsequently, only when there is a system failure or pipeline break. Therefore, the collection system must promote itself and its facilities and systems as a whole. Collection system representatives can talk to schools and make presentations to local officials and businesses about the wastewater field. Managers can participate in local or statewide community activities such as fairs, trade shows, and historic events.

2.1.5 Management Information Systems

The foundation of the authority's management system is their management information system. The ability of the authority to effectively manage its collection system is directly related to its ability to maintain and have access to the most up to date information concerning its facilities. Maintenance of this up to date information is an effort involving all members of the authority from the staff person answering the telephone to the worker in the street. A satisfactory management information system should provide the authority with the following advantages:

- Faster information queries
- Maintain preventive maintenance and inspection schedules
- Provide budgetary justification
- Track repairs and work orders
- Organize capital replacement plans
- Manage tools and equipment inventories
- Print out purchase orders
- Record customer service inquiries/complaints.

Collection systems authorities have been increasingly moving towards computer-based systems to manage data. Only the very smallest systems still rely on paper data management systems. Computer-based Maintenance Management Systems (CMMSs) are designed to manage data needed to track the collection system's O&M performance. Geographic Information Systems (GIS) are used in the field to map and locate system components and because of its computer-based compatibility, can easily be integrated with a CMMS. However, it is important to note that the computer based system can only be as accurate as the data which is being generated in the field, most likely on paper.

Management information systems are critical to the collection system authority in that they help ensure appropriate staffing and budgeting, proper operation and maintenance, and compliance with environmental and safety requirements. Regardless of the management information style chosen, the collection system should have written instructions regarding the use of the management information systems. These procedures may include operating the system, upgrading the system, accessing data and information, and developing and printing reports. The system must be kept up-to date with accurate information.

Types of Management Information Tracking

- Customer service tracking
- Safety incident tracking
- Emergency response tracking
- Process change tracking
- Inspection scheduling and tracking
- Monitoring/sampling schedules
- Compliance tracking
- Planned maintenance, schedules and work orders
- Parts inventory tracking
- Equipment and tools tracking.

Work reports from the field crews must be complete, accurate and legible to be useful. If computer-based, procedures should present the unique hardware and software requirements. The auditor should interview collection system staff on their knowledge of these procedures. The auditor may also select some number of complaints and see how well they can be tracked through the system to an ultimate conclusion. Work reports generated by the field crew should be randomly chosen and scanned for legibility and completeness. The auditor should do a random check of data entry timeliness and accuracy. The auditor should obtain selected original data sources (such as field reports), compare them to the appropriate database output to determine how long entry takes. This will provide a check on how current the data base is and what the data entry backlog is.

2.1.6 SSO Notification Program

The authority must maintain a procedure which ensures that all SSOs are reported to the necessary entities, e.g., drinking water purveyors, the public, and the regulatory authority. The procedure must clearly indicate the chain of communication by which initial notification of an SSO will travel to the proper personnel for reporting. The procedure should include the names, titles, phone numbers and responsibility of all personnel involved. The auditor should verify that the personnel listed in the procedure are still in the position listed for them and are aware of their responsibilities.

The procedure may allow for different levels of response for different types of SSOs. For example, the regulatory authority may request that SSOs due to sewer line obstructions be reported on a monthly basis. Therefore, the procedure may simply be to gather this information from the maintenance information system and have the appropriate personnel put together a reporting form. A chronic SSO at a pump station overloaded during wet weather which discharges to a sensitive water body may require a more complex set of notification procedures, including immediate telephone notification to specified authorities.

The auditor should walk an overflow through the chain of events that would occur from the initial notification by choosing several random overflow events from the complaint records to track and observe if all end up being reported as procedures dictate. The minimum information that should be reported for an SSO includes the date, time, location, cause, flow (may be estimated), how it was stopped and any remediation methods taken. The auditor should not only verify that the SSO notification procedures are appropriate but also verify that the authority has reliable methods for detection of overflows and a phone number or hotline for the public to report overflow events as they happen.

2.1.7 Legal Authority

The collection system authority should maintain the legal authority necessary to regulate input to the collection system. Inputs to the collection system include residential and commercial customers, satellite communities and industrial users. The legal authority may take the form of sewer use ordinances, contracts, service agreements, and other legally binding documents.

The pretreatment program seeks to prevent the discharge of materials into the sewer system by industrial users which interfere with proper operation of the collection system or wastewater treatment plant or cause the wastewater treatment plant to violate its NPDES permit. The pretreatment program has been in place for many years and is well established. The auditor should be aware that the pretreatment program is rarely administered by the collection system authority, rather wastewater treatment plant personnel typically perform this function. At the time the wastewater treatment plant submits their pretreatment program to the regulatory authority, they must include a statement from the City solicitor or other legal authority that the plant has the authority to carry out the program. The auditor should verify the existence of this statement and inquire as to whether any significant changes have occurred in the program such that the legal authority may need further review. Further information on legal authority under the pretreatment program may be found in "Procedures Manual for Reviewing a POTW Pretreatment Program Submission", USEPA, 1983 (NTIS PB93-209880).

The authority must also have in place a sewer use ordinance (SUO). The purpose of the SUO is to protect the collection system from incompatible discharges. The sewer use ordinance should contain, at a minimum, general prohibitions, adequate grease control requirements and measures, prohibitions of storm water inflows and infiltration from laterals and new construction standards.

The grease control section of the SUO should contain the requirement to install grease traps at appropriate facilities (e.g., restaurants) and requirements that facilities that have grease traps properly maintain them and have them pumped out on a regular schedule. The SUO should also address periodic inspections of grease traps by authority personnel (note that this is often a function of the plumbing department) and the ability to enforce, i.e., levy fines on persistent offenders.

General Prohibitions

- Fire and explosion hazards
- Corrosive materials
- Obstructive materials
- Material which may cause interference at the POTW
- Heat which may inhibit biological activity at the POTW
- Oils or petroleum products which may cause interference or pass through at the POTW
- Fume toxicity of reactivity
- Trucked or hauled wastes except at designated points.

The collection system authority should have the power to prohibit storm water connections to the sanitary sewer. Such direct storm water connections are known as inflow. Inflow can severely impact the ability of the collection system to transport flows to the treatment plant during wet weather, leading to overflows and non-compliance with the plant's NPDES permit. Storm water connections may include catch basins; roof, cellar and yard drains; sump pumps; direct connections between the storm and sanitary sewers; and the direct entrance of streams into the collection system. The auditor should be aware that although this practice is now discouraged, during certain periods of time (in most cases prior to 1970), some authorities encouraged the connection of some of these inflow sources to the sanitary sewer system.

The authority should also have the legal authority to control infiltration. Infiltration is the groundwater which enters the collection system through cracks and defects. The SUO should contain provisions for inspection and enforcement for customers contributing infiltration or inflow.

The collection system authority must have the authority to ensure that new and rehabilitated sewers and connections have been properly designed, constructed and tested before being put into service. This should take the form of design and performance specifications in the sewer use ordinance or other legal document. It is especially important that the authority maintain strict control over the connection of private sewer laterals to sewer mains. These connections have significant potential as sources of infiltration. Standards for new connections should be clearly specified. The SUO should contain provisions for inspection and approval by the authority of new connections and a program to implement the requirements. An excellent method to maintain control over existing connections is to require an inspection of the lateral prior to sale of a property. The SUO should also contain enforcement provisions related to lateral sewers.

The collection system authority should have a comprehensive program which addresses flows from satellite communities. Satellite communities must not be allowed to contribute excessive flows that cause or contribute to overflows, flooding or non-compliance at the wastewater treatment plant. Should any of these situations exist, it is not sufficient that the authority merely charges the satellite community for the excess flow. The authority must be able to prohibit the contribution of the excess flow. The auditor should be aware that, historically, control of satellite communities by many authorities was insufficient. The auditor should review all contracts between systems and their satellites (unless too numerous, then select representative contracts). Contracts should have a date of termination and allow for renewal under different terms. Contracts should limit flow from satellite communities and limit wet weather flows.

2.2 Collection System Operation

Collection system operations include those areas of the CMOM program that cannot be referred to as maintenance or administration management. Collection systems have little of what is traditionally referred to as "operability" as compared to a wastewater treatment plant, i.e., the number of ways to route the wastewater is typically limited. However, the design of some collection systems does allow flow to be diverted or routed from one pipe or another or even to different treatment plants. This can be accomplished by redirecting flow at a pump station from one discharge point to another or opening and closing valves on gravity sewers and force mains. There are many reasons why the collection system authority may want to divert flows, among them, to relieve overloading on a system of piping or the wastewater treatment plant or to add more flow to piping serving an area not yet fully developed so as to maintain a cleansing velocity. There should be detailed, written procedures available to guide collection system operators through flow routing activities. Also, there should be operating procedures for mechanical equipment such as pump station pump on/off and service rotation settings or in-line grit removal (grit trap) operations.

2.2.1 Budgeting

The budget is one of the most important variables in the CMOM program. Although an adequate budget is not a guarantee of a well run collection system, an inadequate budget will make this achievement difficult. Funding has significant impacts on staff and their ability to do their job. Funding can come from a variety of sources, including user fees or appropriations from the State or local government. Auditors need to determine the source of the authority's funding and who controls it. Auditors should request to review budget documents, summaries, or pie charts to learn more about the systems' funding.

A key element of the operation budget program is the tracking of costs in order to have accurate records each time the annual operating budget is developed. Having an annual baseline provides documentation for future budget considerations and provides justification for future rate increases. Collection system management should be aware of the procedures for calculating user rates and for recommending and making user rate changes.

Collection system and treatment plant costs will often be combined into one budget, or they may combine portions of the budget in each. For example, electrical and mechanical maintenance work performed by plant staff on a pumping station may be carried as an O&M cost in the treatment plant budget, although pumping stations are generally considered to be a collection system component. Larger authorities should be able to present costs related to collection system only but smaller ones may not be able to.

The cost of preventive and corrective maintenance and major collection system repairs and alterations are major items in the yearly operating budget. The utility should keep an adequate record of all maintenance costs, both in-house and contracted, plus the costs from spare parts. This will assist in the preparation of the next year's budget. In general, there should be an annual (12 month cycle) budget.

<u>Examples of O&M Budget Items</u>

- Motor Vehicles
- Maintenance materials and supplies
- Contracted services
- Chemicals
- Utilities
- Capital
- Labor (usually at least 50% of total budget).

of discretionary and non-discretionary items. There may also be a Capital Improvement Plan (CIP) which may encompass small projects (projects in 1-2 year cycles) or larger projects that may take 3-5 years to complete. Larger projects may include items such as equipment, labor, training, or root cause failure analysis.

The major categories of operating costs are labor, utilities, and supplies. Cost accounting for these categories should include information on unit costs, total costs, and the amount/quantities used. The auditor should review the current and proposed budget, and current year balance sheets. In reviewing current and proposed expenditure levels, the auditor should consider:

- How current sewer (or water/sewer) rates compare to other communities in the region and State. There are several sources for this type of information including the Raftelis Environmental Consulting Group's annual "Water and Wastewater Rate Survey"

- Whether the budgets include contributions to capital reserve (sinking) funds. These funds are savings for replacement of system components once they reach their service life.

- Whether all income from water and sewer billings is utilized only to support those functions, or if they go into the general fund.

2.2.2 Compliance

The Clean Water Act (CWA) prohibits the discharge of pollutants to waters of the United States unless the discharge is authorized by an NPDES permit. The NPDES permit contains limits on what a facility can discharge, monitoring and reporting requirements, and other provisions to ensure that the discharge does not adversely affect water quality or public health. Generally, auditors will find that the NPDES permit regulates discharges from the effluent discharge point at the associated wastewater treatment plant. However, the collection system is an integral part of the entire publically-owned treatment works as a whole and un-permitted discharges from sanitary sewer systems to waters of the U.S. constitute a violation of the CWA, as well as pose a potential public health hazard. Some NPDES permits may contain requirements that explicitly state that SSOs are prohibited.

Furthermore, each NPDES permit contains standard conditions based on current regulatory language at 40 CFR 122.41(e) which states that: "The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit." Poor collection system operation and maintenance practices, particularly those that lead to SSOs, would violate this permit condition. Determining compliance with permit conditions regarding proper operation and maintenance largely involves the evaluation of CMOM programs at collection systems (and treatment plants). As mentioned in Chapter 1, EPA is in the process of proposing regulatory language that would add to the existing language regarding operations and maintenance and other areas relating to SSOs.

Every effort should be made to achieve compliance through O&M program management before regulatory agencies mandate compliance through enforcement. Compliance that is achieved only by the result of administrative orders and consent agreements can consume enormous amounts of time and money.

Under certain circumstances, e.g., as directed by a consent decree or administrative order, collection system agencies may be required to develop compliance tracking systems that include specific requirements and the time periods or dates on which those requirements must be completed. This helps ensure all proper activities are conducted, all reports are submitted in a timely fashion, and that records are maintained for the appropriate amount of time. The auditor's responsibility is to review the decree or order and determine which programs a collection system authority may be responsible for implementing and enforcing and what reports they must submit. Once these determinations are made, the auditor should review all policies and procedures to ensure the various compliance programs are addressed. With or without the presence of an enforcement action, some of the other compliance documents auditors might request could include records of overflows in the system, discharge monitoring reports, or flow records.

2.2.3 Monitoring

The collection system authority may be responsible for fulfilling some water quality or other type of monitoring requirements. They may be responsible for monitoring discharges into the collection system from industrial users, monitoring to determine the effects of SSOs on receiving waters or required to monitor by their NPDES permit, a 308 letter, administrative order or consent decree.

The authority should maintain written procedures to ensure that sampling is carried out in a safe, effective and consistent manner. The procedures should specify, at a minimum:

- Sampling location(s)
- Sample volumes, preservatives, holding times
- Instructions for the operation of any automatic sampling equipment
- Instructions for the operation of any field monitoring equipment (e.g., pH or D.O.)
- Sampling frequency
- Sampling and analytical methodologies
- Laboratory QA/QC

Records should be maintained of sampling events. These records should at a minimum include the following:

- Date, time and location of sampling
- Sample parameters
- Date shipped or delivered to the laboratory

2.2.4 Hydrogen Sulfide Monitoring and Control

Hydrogen sulfide is generated by anaerobic bacteria in slow moving wastewater such as that which sits in a long force main or a pump station wet well or by conditions such as high pH or temperature. The hydrogen sulfide is released when the wastewater undergoes turbulence or aeration. The hydrogen sulfide is converted to sulfuric acid by other bacteria on the pipe wall and corrosion begins to take place. Hydrogen sulfide is a major source of odors and corrosion in collection systems. Hydrogen sulfide corrosion may cause structural failure of the affected component. Structural failure in a force main or gravity line almost inevitably results in an SSO. Hydrogen sulfide is also dangerous to human health in that it is acutely toxic. Hydrogen sulfide smells like rotten eggs but quickly numbs the sense of smell so that it can no longer be detected.

Areas Subject to Generation of Hydrogen Sulfide

- Sewers with low velocity conditions and/or long detention times
- Sewers subject to solids deposition
- Pump stations
- Turbulent areas, such as drop manholes or force main discharge points
- Inverted siphon discharges
- Force main high points.

The collection system authority should have a program under which they monitor areas of the collection system which may be vulnerable to the adverse effects of hydrogen sulfide. It may be possible to perform visual inspections of these areas. The records should note such items as the condition of metal components, the presence of exposed rebar (metal reinforcement in concrete), copper sulfate coating on copper pipes and electrical components, and loss of concrete from the pipe crown or walls. As noted in section 2.4.2 the authority should be carrying out routine manhole inspections. The hydrogen sulfide readings generated as a result of these inspections should be added to the records maintained regarding potential areas of corrosion. A quick check of the pH of the pipe crown or structure will allow for an early indication of potential hydrogen sulfide corrosion. A pH of less than four indicates the need for further investigation. Coupons may be installed in structures or pipelines believed to be potentially subject to corrosion. Coupons are small pieces of steel inserted into the area and measured periodically to determine whether corrosion is occurring. The auditor should be aware that a system in which infiltration and inflow has successfully been reduced may actually face an *increased* risk of corrosion since the reduction of flow through the pipes allows unsubmerged conditions to occur and acid to be deposited.

There are several methods to prevent or control hydrogen sulfide corrosion. The first is proper design. Design considerations are beyond the scope of this manual but may be found in the "Design Manual: Odor and Corrosion Control in Sanitary Sewerage Systems and Treatment Plants" (EPA/625/1-85/018, USEPA, 1985). The level of dissolved sulfide in the wastewater may be reduced by chemical or physical means such as aeration, or the addition of chlorine, hydrogen, peroxide, potassium permanganate, iron salts, or sodium hydroxide. Whenever chemical control agents are used, the collection system authority should have procedures for their application. The authority should also maintain records of the dosages of the various chemicals. Sewer cleaning to remove deposited solids will aid in reducing hydrogen sulfide generation. Air relief valves may be installed at the high points of the force main system. The valve allows air to exit thus avoiding air space at the crown of the pipe where acid can form. The auditor should review the records to see that these valves are receiving periodic maintenance.

It should be noted that collection systems vary widely in their vulnerability to hydrogen sulfide corrosion. Vitrified clay and plastic pipes are very resistant to hydrogen sulfide corrosion. Concrete, steel and iron pipes are susceptible to hydrogen sulfide corrosion. The physical aspects of the collection system are also important. A terrain which encourages the wastewater to move at a higher velocity will be freer of hydrogen sulfide than one where the wastewater may experience longer detention times in the pipes. Therefore, some systems may need a more comprehensive corrosion control program while some might limit observations to vulnerable points.

2.2.5 Safety

The development of a safety program is a necessity for any collection system authority. The purpose of the program is to define the principles under which the work is to be accomplished, to make the employees aware of safe working procedures, and to establish and enforce specific regulations and procedures. The program should be in writing (e.g., written procedures, policies and training courses) and training should be well documented. Although a safety program is not explicitly required under current NPDES regulations, an excessive injury rate among operators may cause an environment where collection system non-compliance is more likely to occur. Furthermore, when good safety practices are not followed, there may be a risk to the public, in addition to the risk to collection system workers.

Collection system operators face a number of hazards in the course of their daily activities. The most common of these hazards are outlined below:

- ***Physical Hazards*** - Most parts of the collection system are wet, slippery and contain sharp corners and edges. Falling objects while working below surface level are also a hazard.

- ***Infections*** - Personal cleanliness is extremely important, as every disease, parasite, and bacteria from a community can end up in the wastewater collection system

- ***Atmospheric Hazards*** - The three major types of atmospheric hazards are explosive/flammable, toxic, and oxygen-deficient. The atmosphere in any confined space should always be tested prior to entry.

- ***Chemicals*** - Exposure to toxic acid or bases (or other hazardous liquid or solid) discharged to the wastewater collection system either by accidental spill or deliberate action is a potential health hazard. Workers should always wear protective clothing to guard against the possibility of exposure to such toxicants.
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- ***Drowning*** - With the construction of bigger and more extensive interceptor pipelines, the chance of drowning while working in manholes is increasing. Harnesses with lifelines attached should always be worn when entering manholes.

- ***Animals*** - Insects and animals can be hazardous. Before entering manholes or other confined spaces, the area should be inspected for insects, spiders, rodents, and snakes.

The purpose of safety training is to stress the importance of safety to the employees of the collection system. Safety training can be accomplished through the use of manuals, meetings, posters, and a safety suggestion program. One of the most common reasons for injury and fatalities in wastewater collection systems is the failure of victims to recognize hazards. Safety training cuts across all job descriptions and should emphasize the need to recognize and address hazardous situations. Safety programs should be in place for the following areas:

- Confined spaces (permit program)
- Chemical handling
- Trenching and excavations
- Material Safety Data Sheets (MSDS)
- Biological hazards in wastewater
- Traffic control and work site safety
- Lockout/Tagout
- Electrical and mechanical safety
- Pneumatic or hydraulic systems safety.

The collection system authority should have written procedures which address all of the above issues and to which operators have convenient access. Safety programs should consist of more than just training and procedures. The program should contain procedures to enforce safety programs, for example, periodic tests or "pop" quizzes to monitor performance/compliance and follow-up on safety related incidents.

The auditor should review these procedures. Each procedure or policy should identify actions to be taken, personnel approved to carry out specific tasks, equipment to be used, and the source of the equipment. The procedures should describe any required instrumentation such as its proper use and any calibration procedures. All permits, approvals and documentation should be described. The auditor should, in the course of interviewing staff, determine their familiarity with health and safety procedures which their job description indicates they should be utilizing.

The collection system authority should maintain all of the safety equipment necessary for the operators to perform their daily activities and also undertake any emergency repairs. This equipment should include, at minimum, the following:

- Atmospheric testing equipment
- Respirators and/or self contained breathing apparatus
- Full body harness
- Tripods or non-entry rescue equipment
- Hard hats
- Safety glasses
- Rubber boots
- Rubber/disposable gloves
- Antibacterial soap
- First aid kit
- Protective clothing
- Confined space ventilation equipment
- Traffic/ public access control equipment.

Each field crew vehicle should have adequate health and safety supplies. If the auditor has access to the municipal vehicle storage area, they might choose to check actual vehicle stocks, not just supplies in storage.

2.2.6 Emergency Preparedness and Response

The collection system authority should have in place a comprehensive plan for dealing with both routine and catastrophic emergencies. Routine emergencies include such situations as overflowing manholes, line breaks, localized electrical failure and pump station outages. Catastrophic emergencies include floods, tornados, earthquakes and other natural events or serious chemical spills or widespread electrical failure. Ideally, this plan is written, reviewed and adjusted accordingly over time.

The auditor should review the plan to determine if it generally follows the guidelines described below. The location where the plan is housed will vary but in general, expect to find such a document in the yard office or other building commonly accessible to and frequented by the collection system operators. The emergency preparedness and response procedures may be contained in the authority's O & M manual, or may be reflected in the descriptions of equipment and unit operations. Putting emergency procedures in a stand-alone document makes it easier for the operator to find information than combining it with other information in the O & M manual.

The plan should utilize the most up-to-date information on the collection system. A structured analysis, or *risk assessment*, should be made of the collection system, treatment plant, and the community. The risk assessment should identify areas where the collection system is vulnerable to failure and determine the effect and relative severity to collection systems operations, equipment and public safety and health of such a failure. The risk assessment should concentrate on such factors as topography, weather, sewer system size, and other site-specific factors which reflect the unique characteristics of the system. Once the areas of vulnerability are known, the authority should have appropriate plans in place to ensure collection system operations continue for the duration of the emergency.

The plans must clearly identify the steps staff should take in the event of emergency situations. They should include information on when it is appropriate to initiate and cease emergency operations. The plans should be very specific as to the collection system or repair equipment involved. Instructions should be available which explain how to operate equipment or systems during an emergency event when they are not functioning as intended but are not fully inoperable. The plan should also include specific procedures for reporting events that result in an overflow or other non-compliance event to the appropriate authorities. Plans should specifically identify emergency situations, responsibilities, actions to be taken, equipment to be used and sources thereof, and notification requirements including those involving regulatory authorities but also other local agencies such as the fire dept, ambulance, etc.

The collection system authority should keep track of emergency situations to become better prepared for future emergencies, and also to assist in or aid reporting and compliance with emergency-related requirements. Typical components of an emergency program may include:

- General information regarding emergencies, such as telephone numbers of collection system personnel, fire department, and ambulance.

- Identification of hazards (e.g., chlorine storage areas) and use of universal classification system for hazards: Combustible material, flammable liquids, energized electrical circuits, and hazardous materials.

- Vulnerability analysis in which the collection system identifies the various types of emergencies that could occur, such as natural disasters, power outages, or equipment failures.

- Emergency response procedures.

- Methods to reduce risk of emergencies.

- Responsibilities of staff and management.

Collection system operators must be prepared to respond to routine emergencies with resources that include appropriate procedures, spare parts, repair materials and equipment. Extraordinary emergencies caused by natural events or manmade events tend to affect wider areas and other utilities. These emergencies require greater time and resources due to the complexity of coordinating an effective response. Therefore, it is essential to have in place an effective emergency management plan to reduce the impact of extraordinary and routine emergencies.

Procedures for the emergency response plans should be understood and practiced by all personnel in order to ensure safety of the public, and the collection system personnel responding. Procedures need to be specific to the type of emergency that could occur. It is important to keep detailed records of all past emergencies in order to constantly improve response training, and the method and timing of future responses. The ability to deal with emergencies depends on the knowledge and skill of the responding crews, in addition to availability of equipment. The crew needs to be able to rapidly diagnose problems in the field under stress, but they must also select the right equipment needed to correct the problem. Crews therefore need immediate access to appropriate tools and equipment if emergencies are to be dealt with as rapidly as possible. If resources are limited, consideration should be given to contracting other departments or private industries to respond to some emergency situations, for example, those emergencies that would occur after normal hours of operation.

2.2.7 Modeling

A model is a computer program that is capable of simulating the different flows within the collections system. Modeling is a tool that may be used to assess the collection system's capacity under various flow scenarios. If a collection system is not experiencing any capacity related issues, i.e., overflows, bypasses, basement backups, street flooding, hydraulic overload at the treatment plant, etc. then maintenance of a model may be optional for that system, although most medium and large systems should maintain a model of the larger diameter portion of their system. If any of the mentioned conditions are occurring then maintenance of a model is essential to performing a capacity assessment in the problem areas.

The purpose of modeling is to determine system capacity requirements with respect to sewer design and structural conditions. Therefore the input of accurate data on sizes, location and condition of sewer system components such as pipes, manholes, pump stations is necessary. When possible flow monitoring data should be integrated into the model. Ultimately, an accurate picture provided from modeling techniques can give the operator information on system performance. Modeling is also useful in examining effects before and after rehabilitation. For example, models can be calibrated with "before" and "after" flow monitoring to estimate the effects of the repairs.

Auditors should determine whether the model being used by the collection system authority meets the following minimum criteria:

- The model should have support. Support means that a user can obtain help with problems that arise during model implementation and use.

- The model should have adequate documentation. This should include a user's manual that describes data input requirements, output to be expected, model capabilities and limitations, and hardware requirements.

- The model should have been demonstrated by users other than its developers.

The model also needs to be properly calibrated. Improperly calibrated models may yield under- or over-estimations of flow. Calibration involves comparing actual flow measurements to those generated by the model. For wet weather modeling comparison two to three storms is generally adequate.

Computer modeling is a specialized and complex subject. The auditor may not have a comprehensive knowledge of modeling. If this is the case the auditor should obtain the following basic information:

- Is the authority using a model?
- What areas of the collection system are being modeled and why?
- What model (including the version) is being used? Who developed the model and when?
- How are the modeling results being used?

2.2.8 Engineering

The importance of maintaining accurate, up to date maps of the collection system cannot be overestimated. Efficient collection system maintenance and repairs are not possible if mapping is not adequate. Collection system maps should clearly indicate the information that operators need to carry out their assignments. The collection system maps should contain the following information:

- Location of Collection System Elements
  - Main, Trunk and Interceptor Sewers
  - Building Sewers
  - Manholes
  - Cleanouts
  - Force Mains
  - Pump Stations
  - Municipal or Other Boundaries
  - Other Landmarks (Roads, Water Bodies, etc.)

Collection system maps should have a numbering system which uniquely identifies all manholes and sewer cleanouts. The system should be simple and easy to understand. Manholes and sewer cleanouts should have permanently assigned numbers and never be renumbered. Maps should also indicate the property served and reference its cleanout.

Sewer line maps should indicate the diameter, the length between the centers of the up and downstream manholes and the direction of flow. The dimensions of easements and property lines should be included on the maps. Other information to be included on maps are access and overflow points, a scale and a north arrow. All maps should have the date the map was drafted and the date of the last revision. Optional information often included on maps is pipe materials. Maps may come in different sizes and scales to be used for different purposes. Detailed local maps may be used by maintenance or repair crews to perform the duties. However, these detailed local maps should be keyed to one overall map that shows the entire system.

Geographic information systems (GIS) have made the mapping and map updating process considerably more efficient. GIS is a computerized mapping program capable of combining mapping with detailed information about the physical structures within the collection system. If a GIS program is being used by the authority, the auditor should ask if the program is capable of accepting information from the authority's management program.

It is important that there are specific procedures established for correction of errors and updating maps and drawings. Field personnel must be properly trained to recognize discrepancies between field conditions and map data and to record changes necessary to correct the existing mapping system. The accuracy of the drawings used by field personnel and contractors are critical to proper identification of sewer collection system components. Auditors should check to see that maps and plans are available to the operator in the office and to field personnel or contractors involved in all engineering endeavors.

The collection system authority should maintain strict control over new construction. New construction may be public (i.e., an expansion of the authority's system) or private (i.e., a developer constructing sewers for a new development). Quality sanitary sewer designs keep costs and problems associated with operations, maintenance, and construction to a minimum. Design flaws are difficult to correct once construction is complete. The auditor should be aware that this has historically not been adequately addressed by some authorities. The authority should have standards for new construction, procedures for reviewing designs and protocols for inspection, start up, testing and approval of new construction. The procedures should provide for documentation of all activities, especially inspection. Auditors should review construction inspection records; does the volume of records seem reasonable given system size, and do records reflect that the authority's public works auditors are complying with procedures? The State or other regulatory authority may also maintain standards for new construction. The authority's standards should be at least as stringent. Start up and testing should be in accordance with the manufacturers' recommendation where applicable and with recognized industry practices. Each step of the review, start-up, testing and approval procedures should be documented.

The authority's approval procedure should reflect future ease of maintenance concerns. During public construction the authority should maintain a public works auditor at the job. The public works auditor notes that the construction is taking place in accordance with the plans, that the correct quality of materials are being used, that the pipe is being bedded suitably, and that joints and fittings are properly attached, among other things. Further details on the duties of the auditor may be obtained from the Public Works Auditor's Manual, available from Building News, 3055 Overland Ave. Los Angeles CA, 90034. After construction is complete, the authority should have a procedure for construction testing and inspection. Construction supervision should be provided by qualified personnel such as a registered professional engineer.

Key Design Characteristics

- Line locations, grades, depths, and capacities
- Maximum manhole spacing and size
- Minimum pipe size
- Pumping Station dimensions and capacities
- Drop manholes
- Flow velocities and calculations (peak flow and low-flow)
- Accessibility features
- Other technical specifications (e.g., materials, equipment).

2.2.9 Pump Stations

Pump stations are used for lifting wastewater to a higher elevation or in areas where pipe cannot be installed to meet a minimum cleansing velocity. Lift stations are a type of pump station which discharge to a gravity sewer rather than a force main. Operation, maintenance and repair of pump stations requires special electrical, hydraulic and mechanical knowledge. Pump station failure may result in damage to equipment or the environment or endanger public health. Proper design, construction and operator training are also important. Variation in equipment types, pump station configuration, and geographical factors determine pump station design and O& M requirements. All pump stations (with the exception of those continuously staffed and very small pump stations) should be equipped with at least the most basic telemetry system, one which transmits a high water level alarm to a central location. The auditor should note that the are still many systems which lack telemetry. Even very small pump stations should be equipped with an audible/visual overflow alarm.

Pumps should be operated near their rated heads (i.e., the flows and pressures they experience should be within the manufacturer's intended guidelines). This information should be available in the authority's O&M manual. It is generally not good practice to vary a pump's capacity by throttling (i.e., restricting flow on the pump's discharge side). This produces excessive wear and tear on the pump and the valve. To account for varying flows, a pump station typically contains three or more pumps (very small stations may contain only two). One pump is the lead, one is the lag and one is the backup, which is activated when one of the other pumps fails. Pumps should be rotated (i.e., all pumps should take turns being lead, lag and backup). This spreads the wear and tear on the pumps evenly. In most cases a pump station should have enough capacity to pump the peak flow it will experience with the largest pump out of service. The wet well levels control the number of starts the pump motor will make in any given time period. Motors of 100 HP or less should typically be limited to less than five starts per hour and motors over 100 HP to progressively less down to one start per hour.

The auditor should inquire as to the following pump station operations and also note whether there are procedures in writing:

- Are pumps rotated manually or automatically?
- If manually, how frequently?
- Are wet well operating levels set to limit pump start/stops?
- Is there a procedure for manipulating pump operations (manually or automatically) during wet weather to increase in-line storage of wet weather flows?
- Is flow monitoring provided? How is the data collected used?
- Does the pump station have capacity-related overflows? Maintenance related overflows? Is overflow monitoring provided?

- Is there a history of power outages? Is there a source of emergency power? If the emergency power source is a generator is it regularly exercised under load?

2.3 Collection Systems Maintenance Programs

Every collection system authority should have a well planned, systematic, and comprehensive maintenance program. The program should be in writing and should encompass varying degrees of detail. The overall maintenance strategy should express the goals and overall approach. The goals of a maintenance program should include:

- Prevention of overflows
- Maximization of service and system reliability at minimum cost
- Insurance of infrastructure sustainability (i.e. ensure all components reach their service life).

There should then be procedures which describe the maintenance approach for various systems. Finally there should be detailed instructions of the maintenance and repair of individual collection system components. These instructions should provide a level of detail such that any qualified operator or repair technician could read them and perform the repair or maintenance activity.

Maintenance may be planned or unplanned. There are essentially two types of planned maintenance; predictive and preventive. Predictive maintenance is a method that tries to provide early warning of equipment failure such that emergency maintenance is avoided. Preventative maintenance is comprised of scheduled maintenance activities performed on a regular basis. There are two types of unplanned maintenance, corrective and emergency. Corrective maintenance consists of scheduled repairs to problems identified under planned or predictive maintenance. Emergency maintenance is activities (typically repairs) performed in response to a serious equipment or line failure where action must be taken immediately. The goal of every collection system authority should be to reduce corrective and emergency maintenance through the use of planned and predictive maintenance. The auditor must try to determine how close the authority is to achieving that goal. The goals of the auditor in assessment of the authority’s maintenance program are:

– Identify SSOs caused by inadequate maintenance;
2. Determine if too much emergency maintenance is being performed;
3. Identify sustainability issues (i.e. inadequate maintenance to allow system components to reach service life and/or many components nearing/at service life).

2.3.1 Maintenance Budgeting

The cost of a maintenance program is a significant part of the authority’s annual operating budget. The collection system authority must accurately track all maintenance costs incurred throughout the year, both by internal staff and contractors, to ensure that the budget is appropriate and representative of the costs of past years. Budgets must be developed from past cost records and usually are categorized according to preventive maintenance, corrective maintenance, and projected and actual major repair requirements. Annual costs must be compared to the budget periodically to control maintenance expenditures. Evaluating costs this way serves to control expenditures and provides a baseline for future budgets. The auditor should review the maintenance budget keeping in mind the system's characteristics, such as age. Maintenance should be the largest part of most systems' budget. Exceptions to this rule may be systems with many pump stations which have high energy costs or those doing major structural rehabilitation which will have large capital improvement budgets. Costs for emergency repairs should be relatively small percentage of the budget, 5-10 % would not be considered excessive. Budget should also be considered in light of maintenance work order backlog. The auditor should review the labor budget for consistency with local pay rates and staffing needs (is it appropriate to the system's size per tables previously provided in section).

The auditor may also want to discuss budget development with the utility's upper management. Topics should include how budget costs are projected. Are the operating staff's requests for funding seriously considered? Do they get most/much/some of what is requested? If possible the auditor should review past year's budgets to determine whether budgets have increased over the years somewhat in line with inflation (or the CPI or ENR's indices, etc.).

2.3.2 Planned and Unplanned Maintenance

A planned maintenance program is a systematic approach to performing maintenance activities such that equipment failure is avoided. Planned maintenance is composed of predictive and preventative maintenance. Some collection system authorities find it difficult to devote an appropriate level of resources to the planned maintenance program because their resources are tied up with corrective and emergency maintenance. Such systems may need to devote extra resources to planned maintenance until corrective and emergency needs are reduced. A planned maintenance program will always produce resource efficiency in the long run. In the end, a good planned maintenance program should reduce material and capital repair and replacement costs, improve personnel utilization and morale, reduce SSOs and sustain public confidence.

Examples of predictive maintenance includes monitoring equipment for early warning signs of impending failure, such as excess vibration, heat, dirty oil, and leakage. All assessment/inspection activity can be classified as predictive maintenance. Vibration and lubrication analyses, thermography, and ultrasonics are among the more common predictive maintenance tools. The auditor should inquire as to whether any of these tools are used, and obtain information on the extent of the programs. Predictive maintenance also takes into account the historical information about the system as all systems will deteriorate over time. A predictive maintenance program strives to identify potential problem areas and uncover trends that could affect equipment performance.

Predictive maintenance offers an early warning. It allows the operator to detect early signs of increasing rates of wear and therefore failure, and thus shift a "corrective" task into a "planned" task. To be truly effective it should not push the operator into doing the work too soon and wasting useful life and value of the equipment in question.

The basis of a good predictive maintenance program is record keeping. Only with accurate record keeping can baseline conditions be established, problem areas identified and a proactive approach taken to repairs and replacement. The predictive maintenance program will utilize the records generated by the preventative, corrective and emergency maintenance. An example of this utilization might be a vitrified clay pipe with minor cracks identified by closed circuit television (CCTV) inspection. Action may be limited to inspection until an increase in cracking occurs. When the increase occurs the authority should investigate the cause and schedule repair as needed.

Effective preventive maintenance minimizes system costs by reducing breakdowns and thus the need for corrective or emergency maintenance, improves the system's reliability by minimizing the time equipment is out of service, increases the useful life of equipment, thus avoiding costly premature replacement, and avoids potential non-compliance situations. An effective preventative maintenance program will include the following items:

- Scheduling: based on system specific knowledge.
- Trained personnel and an explanation of their duties.
- Detailed instructions related to the maintenance of various pieces of equipment.
- A system (preferably computerized) for record keeping.
- System knowledge in the form of maps, historical knowledge and records.

An effective preventative maintenance program will build on the inspection activities and predictive maintenance described in sections 2.4.1 to 2.4.4.

An important component to an effective preventative maintenance program is developing the schedule. The basis of the schedule for mechanical equipment (i.e. generally pump station components)should be the manufacturers' recommended maintenance activities and frequencies. This schedule may then be augmented by operator knowledge and experience to reflect the equipment specific requirements. The schedule for sewer line cleaning, inspection, root removal, and repair activities should be based on data from periodic manhole and CCTV inspection data. In most systems, uniform frequencies for sewer line

<u>Lubrication</u>

Lubrication is probably one of the most important maintenance activities for mechanical systems such as pumps and motors. Frequency of lubrication, choice of lubricant and lubrication procedure are all important factors in this activity. These items should closely follow manufacturer instructions, but may be modified to fit collection system specific factors and particular equipment applications.

cleaning, inspection, and root removal are not necessary, and are inefficient. In many systems, a relatively small percentage of the pipe generates most of the problems.

Efficient use of inspection data allows the authority to schedule in the most constructive manner. In rare cases it may be appropriate to reduce maintenance frequency for a particular piece of equipment. An example of a scheduling code and maintenance schedule for a pump is shown below.

Rotary Pump Maintenance Schedule	
Frequency	**Maintenance Required**
D	Check packing gland assembly
D	Check discharge pressure
S	Inspect and lubricate bearings
A	Flush bearings and replace lubricant

D	=	Daily	W	=	Weekly
M	=	Monthly	Q	=	Quarterly
S	=	Semiannually	A	=	Annually

Typically, there is a maintenance card or record for each piece of equipment within the collection system. These records contain the maintenance recommendations, maintenance schedule, and instructions on conducting the specific maintenance activity. The records should include documentation regarding any maintenance activities conducted to date and other observations related to that piece of equipment or system. Maintenance records are generally kept in the yard office or other location where maintenance personnel will have easy access to them. The auditor should review the full series of periodic work orders (i.e. weekly, monthly, semi-, and annually) for a selection of system components (e.g., a few pump stations, several line segments) The auditor should then compare the recommended maintenance frequency to that which is actually being carried out. The auditor should also look at the backlog of work. The auditor should not focus solely on the number of backlogged work orders (WOs), but on what that number represents in time. A very large system can have a hundred orders backlogged and only be one week behind. In a computerized system, listing of all open work orders is usually very simple for the operator to generate. The authority should be able to explain their system for prioritizing work orders.

Unplanned maintenance is that which takes place in response to equipment breakdowns or emergencies. Unplanned maintenance may be corrective or emergency maintenance. Corrective maintenance could occur as a result of preventative or predictive maintenance activities which identified a problem situation. A work order should be issued so that the request for corrective maintenance is directed to the proper personnel. An example of non-emergency corrective maintenance could be a broken belt on a belt driven pump. The worn belt was not detected and replaced through preventative maintenance and therefore the pump is out of service until corrective maintenance can be performed. Although the pump station may function with one pump out of service, should another pump fail, the situation may become critical during peak flow periods.

If the information can be easily generated the auditor should select a sampling of work orders and compare them to the corrective maintenance database to determine if repairs are being made in a timely manner. The authority should be questioned on the reasons for delay where repairs are exceeding six months. Auditors should note the current backlog of corrective maintenance work orders. A corrective maintenance backlog of two weeks or less would indicate an authority in control of corrective maintenance. The authority should be able to explain corrective maintenance work orders that have not been completed within six months. The auditor needs to clearly understand how the maintenance data management system works, how work orders are generated and distributed, how field crews use the work orders, how data from the field is collected and returned, and how and on whose authority work orders are closed out. The auditor should check to see if data entry is timely and up to date.

Corrective maintenance takes resources away from predictive and preventative maintenance. When corrective maintenance is the major type of maintenance activity, operators may not be able to perform planned maintenance, thus leading to more corrective maintenance and emergency situations.

Emergency maintenance is a form of corrective maintenance that occurs when a piece of equipment or system fails, creating a threat to public health, environment, or associated equipment. This is a special case of corrective maintenance in that the failure may result in potentially severe or catastrophic effects. This type of maintenance involves repairs, on short notice, of malfunctioning equipment or sewers. A broken force main, totally non-functional pump station and street cave-ins are all examples of emergency situations.

Types of Portable Emergency Equipment

- Bypass pumps
- Portable generator
- Air compressor, trailer-mounted
- Manhole lifters and gas testing equipment
- Sewer rodder and/or flushing machine
- Portable lights and hand tools
- Chemical spray units (for insects and rodent control)
- Truck (1-ton) and trailers
- Repair equipment for excavation(backhoe, shoring equipment, concrete mixers, gasoline operated saws, traffic control equipment, etc.)
- Confined space entry gear.

Emergency crews should be geared to a 24-hour-a-day, year-round operation. Most large systems have staffed 24 hour crews; many small systems have an "on call" system. The authority should be able to produce written procedures which spell out the type of action to take in a particular type of emergency, and the equipment and personnel requirements necessary to carry out the action. The crews should have the procedures and be familiar with them. Equipment must be located in an easily accessible area and be ready to move in a short period of time. Vehicles and equipment must be ready to perform under extreme climatic conditions if necessary. Equipment must be checked and maintained often to ensure performance in emergencies. Alternatively, vehicles and equipment can be operated on a routine basis on other maintenance duties to ensure. The emergency crew may need materials such as piping, pipe fittings, bedding materials and concrete. The authority should have supplies on hand to allow for two point (i.e. segment, fitting or appurtenance) repairs of any part of its system. The auditor should note the presence of these supplies during the inspection of the yard which is the area where equipment, supplies and spare parts are maintained and personnel are dispatched.

Pump stations with their combination of electrical, mechanical and structural components, are probably the most maintenance intensive items in the collection system. A pump station maintenance program should be based on two factors. First is the equipment manufacturers' recommendations for such activities as lubrication of bearings, oil changes, and parts replacement. The manufacturers' recommendations should be followed closely during the warranty period to avoid invalidating the warranty. In general, they should be followed closely thereafter as well. The collection system authority should be able to readily produce the manufacturer's recommended maintenance schedules in the original manuals.

The second factor is the specific requirements of the individual pump station. These are items developed by the operators and their supervisors that are based on observations of the pump station. For example, the pump station may be serving an area that is not fully developed yet and the wastewater arrives at the pump station in a septic condition. The pump station in this case may require extra maintenance procedures. As the areas develop and flows increase it may be appropriate to decrease the frequency of some of the procedures. This factor should also include knowledge gained by experience of local conditions. Extremes of heat or cold may require the use of lubricants different than those in more temperate climates.

Pump stations should be subject to inspection and preventative maintenance on a regular schedule. The frequency of inspection may vary from once per week for a reliable pump station equipped with a telemetry system to a continuously staffed large pump station. The basic inspection should include verification that alarm systems are operating properly, wet well levels are properly set, all indicator lights and voltage readings are within acceptable limits, suction and discharge pressures are within normal limits, that the pumps are running without excessive heat or vibration and have the required amount of lubrication. Less frequent inspections may include such items as vibration analysis, and internal inspection of pump components. Occasionally a supervisor should perform an unscheduled inspection to confirm that tasks have been performed as expected.

A typical weekly pump station inspection should include observations of the following:

- The components comprising the alarm system, i.e., the wet well controller and electrical system, note how the pumps are sequenced.
- The pumps: bearings, packing, seals, suction and discharge pressures.
- The pump motors: temperature, amperage and voltage, coupling and alignment.
- Valves: check and pressure relief valves
- Check oil levels and lubrication
- Check belt wear and tightness
- Exercise the emergency generator (if present).

Observations and tasks performed should be recorded in a log book or on a checklist which is typically maintained at the pump station. It is importance to note how this data returns to the central maintenance data management system. At the time of the inspection the operator may perform minor repairs if necessary. If non-emergency repairs are required that are beyond the operator's training it will probably be necessary to prepare a work order which routs a request though the proper channels to initiate the repair action. During the CMOM audit the auditor should check a random number of work orders to see how they move through the system. The auditor should note whether repairs are being carried out promptly. In pump stations, for critical equipment (pumps, drives, power equipment, and control equipment), there should not be much backlog, except for waiting for parts.

During the CMOM audit, the auditor should perform on-site observations for at least a representative percentage of the system's pump stations. For a system with only five pump stations this could include all of them. For the largest systems it may be possible to only inspect 10% or even less. The auditor should plan on taking a half of an hour to look at the simplest two pump prefabricated station, and 1-2 hours to look at a larger station. In large systems drive time between stations may be significant. The auditor should strive to see a sampling of sizes and types; i.e., the largest, smallest, most remote and any which their review of work orders has indicated might be problematic.

Overall, the pump station should be clean, in adequate structural conditions and exhibit a minimal odor. The auditor should note the settings of the pumps, i.e., which are operating, which are on stand-by, and which are not operating and why. The operating pumps should be observed for noise, heat and excessive vibration. The settings in the wet well should be noted (as indicated on the controls, direct observation in the wet well is not recommended) and the presence of any flashing alarm lights. The auditor is reminded of the atmospheric hazards in a pump station (make sure ventilation has been running prior to arrival) and to avoid confined space entry. If the pump station has an overflow its outlet should be observed, if possible, for signs of any recent overflows such as floatable materials or toilet paper. The auditor should check the log book/checklist typically kept at the pump station location and ensure that records are up-to-date and all maintenance activities have been performed. Below is a listing of observations for the auditor which are signs of inadequate maintenance:

- Generally poor housekeeping and cleanliness.
- Excessive grease accumulation in wet well
- Excessive corrosion on railings, ladders and other metal components

- Sagging, worn, improperly sized or inadequate belts
- Excessive equipment out of service for repair or any equipment for which repair has not been ordered (i.e. a work order issued).
- Pumps running with excessive heat, vibration or noise
- Peeling paint and/or dirty equipment; the care given to equipment's outer surfaces often (but not always) mirrors internal condition.
- Check valves not closing when pumps shut off.
- Inoperative instrumentation, alarms and recording equipment
- Inoperative instrumentation, alarms and recording equipment
- "Jury-rigged" repairs (i.e., "temporary" repairs using inappropriate materials).
- Leakage from pumps, piping or valves (note that some types of pump seals are designed to "leak" seal water).
- Inadequate lighting or ineffective/inoperative ventilation equipment.

2.3.3 Sewer Cleaning

Sewer cleaning is necessary to remove accumulated material from the sewer and restore free flow conditions. Cleaning helps to prevent blockages and is also used to prepare the sewer for inspections. Stoppages in gravity sewers are usually caused by a structural defect or poor design, an accumulation of material in the pipe (especially grease) or root intrusion. Protruding taps (lateral sewer connections incorrectly installed so that they protrude into the main sewer) may catch debris which then causes a further buildup of solids that will eventually block the sewer. If the flow is retarded to less than approximately 1.0 to 1.4 feet per second, inorganic grit and organic solids will accumulate in the invert of the piping leading to a potential blockage.

Results of Various Flow Velocities

Velocity	Result
2 ft/sec......................	Very little material buildup in pipe
1.4-2.0 ft/sec.............	Heavier grit (sand and gravel) begin t o a c

There are three major methods of sewer cleaning-hydraulic cleaning, mechanical cleaning, and chemical cleaning. Hydraulic cleaning (also referred to as flushing) refers to any application of water to clean the pipe. Mechanical cleaning uses physical devices to scrape, cut, or pull material from the sewer. Chemical cleaning can facilitate the control of odors, grease buildup, root growth, corrosion, and insect and rodent infestation. A

Sewer Cleaning Records

- Date, time and location of stoppage or routine cleaning activity
- Method of cleaning used
- Cause of stoppage
- Identity of cleaning crew
- Further actions necessary/initiated
- Weather conditions.

reference for the auditor who wants further information of sewer cleaning methods is "Operation and Maintenance of Wastewater Collection Systems", California State University, Sacramento.

An effective preventative maintenance cleaning program will reduce the number of stoppages occurring in the sewer system. The backbone of an effective preventative maintenance cleaning program is accurate record keeping. Accurate record keeping provides the authority with information on the areas of the collection system susceptible to stoppages such that all portions of the system can be put on an appropriate preventative cleaning schedule. The auditor should review the records generated by the field crews for legibility and completeness. The auditor should then review the database to determine whether up to date and accurate entry of the field notes are being entered.

Common Sewer Cleaning Equipment

Jet Cleaning Equipment: Hydrocleaning, or jet, equipment uses high pressure water jets to blast grease and sediment loose from the pipe inner surface. Hand-held jet sprays are also used to clean manholes.
Hydraulically Propelled Cleaning: These systems use plugs, flexible inserts, and balls, which are pushed through the sewer by water pressure and which in passing through the sewer scrape grease and accumulated sediment from the pipe wall.
Mechanical Cleaning Equipment: This equipment uses buckets and rods to break through blockages and remove material from sewers.

Sewers vary widely in their need for preventative cleaning. The collection system in a restaurant district may require cleaning every six months in order to prevent grease blockages. An area of the sewer system with new PVC piping and no significant grease contribution with reasonable and consistent slopes (i.e. no sags) may be able to go five years with no problems. The authority representative should be able to identify problem collection system areas, preferably on a map, by location and potential problem. Potential problem areas identified should include those due to grease or industrial discharges, hydraulic bottlenecks in the collection system, areas of poor design (e.g., insufficiently sloped sewers), areas prone to root infestation, sags and displacements. The connection between problem areas in the collection system and the preventative maintenance cleaning schedule should be clear. The collection system authority should also be able to identify the number of stoppages experienced per mile of sewer pipe. This number should steadily decrease with time. If the system is experiencing a steady increase in stoppages the auditor should try to determine the cause (i.e., lack of preventative maintenance funding, deterioration of the sewers due to age, an increase in grease producing activities, etc).

2.3.4 Parts and Equipment Inventory

An inventory of spare parts, equipment, and supplies must be maintained by the collection system authority. Without such an inventory, the collection system may experience long down times or periods of inefficient operation in the event of a breakdown or malfunction. The inventory should contain information from the equipment manufacturer's recommendations, supplemented by historical experience with maintenance and equipment problems.

Basic Equipment Inventory

- Type, age and description of the equipment
- Manufacturer
- Fuel type and other special requirements
- Operating costs and repair history.

Files should be maintained on all pieces of equipment and major tools. An important consideration in caring for a good stock of tools is to have regular places of storage. The authority should have a system to assure that each crew always has adequate tools. Tools should be subject to sign out procedures to provide accountability. It is important that tools and equipment are replaced at the end of their useful life. The auditor should inquire as to how this is determined and how funds are made available to ensure this is the case. Finally the auditor should look at the tools and note their condition.

All authorities should maintain a yard where equipment, supplies and spare parts are maintained and personnel are dispatched. Very large authorities may maintain more than one yard. In this case the auditor should perform a visual inspection at the main yard. In small to medium size authorities, collection system operations may share the yard with the department of public works, water department or other municipal authority. In this case the auditor should determine what percentage is being allotted for collection system items. The most important feature of the yard is the convenience and accessibility that it provides. Equipment should be easily accessible. An example of this is a yard where trucks are provided with enough room that they do not need to drive in reverse.

Collection system maintenance staff may be typically divided into four specific crews: inspection, routine maintenance, repair work, and emergencies (although they should be cross trained to some extent). The boxes below describe typical equipment that inspection and routine maintenance crews may bring into the field:

Inspection Crew Equipment	Maintenance Crew Equipment

Sewer Cleaning Equipment Video camera & equipment; usually a dedicated truck or trailer Flow meters or sampling devices Safety harnesses and tripods Air monitoring meters (3 or 4 way) Air blower, smoke bombs Dye Spare manhole cover and seals Ladder and canvas buckets Hand tools and mirrors Powerful lights	Sewer cleaning equipment Bucket machines High-velocity cleaning machine Rodding machine Vacuum truck Sewer balls or scooters Pumps and hoses Portable generator with lights Ladders and assorted tools Confined space entry and personal safety equipment

The auditor should observe a random sampling of inspection and maintenance crew vehicles for equipment as described above.

A review of the equipment and manufacturer's manuals will aid in determining what spare parts should be maintained. The authority should then consider the frequency of usage of the part, how critical the part is and finally how difficult the part is to obtain when determining how many of the part to maintain. Spare parts should be kept in a clean, well-protected stock room. The authority should have a procedure for determining which spare parts are critical. Critical parts are those which are essential to the operation of the collection system. Like equipment and tools management, a tracking system should be in place, including procedures on logging out materials, when maintenance personnel must use them. The authority should be able to produce their spare parts inventory and clearly identify those parts deemed critical. The auditor should review the inventory and selected items in the stockroom to determine whether the required number of these parts are being maintained.

2.4 Sewer System Capacity Evaluation

Collection system authorities should have in place a program to periodically evaluate the capacity of the sewer system in terms of both wet and dry weather flows. The capacity evaluation program should consist of ongoing activities, including flow monitoring, manhole and pipe visual inspections, smoke and dye testing, and CCTV. The capacity evaluation program is aimed at ensuring the maintenance of the collection system's capacity as designed. The capacity evaluation program builds upon the everyday preventative maintenance that takes place in a system.

The capacity evaluation begins with an inventory and characterization of the system components. The inventory should include basic information about the system:

- Population served
- Total system size in feet or miles

- Inventory of pipe lengths , sizes, materials and ages, interior and exterior condition as available
- Inventory of appurtenances such as bypasses, siphons, diversions, pump stations, tide or flood gates and manholes, etc., including size or capacity, materials and ages, condition as available
- Force main locations, lengths, sizes and materials, condition as available
- Pipe slopes and inverts.

The system then undergoes inspections (described in sections 2.4.1-2.4.4) which serve to continuously update and add to the inventory information. The ongoing inspection program serves the purpose of maintaining a database of current conditions in the collection system, helps reduce failures by allowing minor repairs to be performed before major repairs are necessary and provides for early identification of extraneous water entering the system.

The next step in the capacity evaluation is the identification of SSOs, surcharged lines, basement backups and any other areas of known capacity limitations. These areas will warrant further investigation in the form of flow and rainfall monitoring and inspection procedures to identify and quantify the problem. The capacity evaluation should include estimates of peak flows experienced in the system, flow from SSOs, the capacity of key system components, and identify the major sources of I&I that contribute to hydraulic overloading events. The capacity evaluation should also make use of the hydraulic model identified in Section 2.2.7 to identify areas with hydraulic limitations and evaluate alternatives to alleviate capacity limitations. Short and long term alternatives to address hydraulic deficiencies should be identified and priorities and a schedule set for implementation.

2.4.1 Flow Monitoring

Fundamental information about the collection system is obtained by flow monitoring, namely how much wastewater is conveyed through the system by pipes, pump station and force mains. Flow monitoring will provide information on dry weather flows as well as areas of the collection system potentially affected by infiltration and inflow. Flow measurement may also be performed for billing purposes, to assess the need for new sewers in a certain area or to calibrate a model. There are basically three techniques for monitoring flow rates: permanent, long-term monitoring, temporary monitoring, and instantaneous monitoring. Permanent installations are done at key points in the collection system such as the entry point of a satellite collection system, pump stations, and key junctions. Temporary monitoring consists of flow meters typically installed for 30-90 days. Instantaneous flow metering is performed by the operator, one reading is taken and then it is removed.

The authority should have a flow monitoring plan that describes their flow monitoring strategy or should at least be able to provide the following information:

- Purpose of the flow monitoring
- Location of all flow meters
- Type of flow meters
- Flow meter inspection and calibration frequency.

A flow monitoring plan should provide for routine inspection, service and calibration checks (as opposed to actual calibration). In some cases, the data is calibrated rather than the flow meter. Each meter should be checked every week. Checks should include taking independent water level (and ideally velocity readings), cleaning accumulated debris and silt from the flow meter area, downloading data (sometimes only once per month), and checking the desiccant and battery state. Records of each inspection should be maintained.

Flow measurements performed for the purpose of quantifying infiltration and inflow (I&I) are typically separated into three components: base flow, infiltration, and inflow. Base flow is generally taken to mean the wastewater generated without any I&I component. Infiltration is the seepage of groundwater into pipes or manholes through defects such as cracks, broken joints, etc. Inflow is the water which enters the sewer through direct connections such as roof leaders, direct connections form the storm drains, yard, area and foundation drains, the holes in and around the rim of manhole covers, etc. Many authorities add a third classification, rain induced infiltration (RII). RII is storm water that enters the collection system through defects that lie so close to the ground surface that they are easily reached. Although not from piped sources, RII tends to act more like inflow than infiltration.

The authority should have in place a program for the efficient identification of excessive I&I. The program should look at the POTW, pump stations, permanent meter flows and rainfall data to characterize peaking factors for the whole system and major drainage basins. Temporary meters should be used on a "roving" basis to identify areas with high wet weather flows. Areas with high wet weather flows should then be subject to inspection and rehabilitation activities.

2.4.2 Manhole and Pipeline Inspection

Visual inspection of manholes and pipelines in the sewer system are the first line of defense in the identification of existing or potential problem areas. Visual inspections should take place on both a scheduled basis and as part of any preventative or corrective maintenance activity. Visual inspections provide additional information concerning the accuracy of system mapping, the presence and degree of I/I problems, and the physical state-of-repair of the system. By observing the manhole directly and the incoming and outgoing lines with a mirror, it is possible to determine structural conditions, the presence of roots, condition of joints, depth of debris in lines, depth and approximate velocity of flow, and location and estimated rates of any observed infiltration. The auditor should review the records of visual inspections to ensure that the following information is being recorded:

- Manhole identifying number/location
- Cracks or breaks in the manhole or pipe (inspection sheets/logs should record details on defects)
- Accumulations of grease, debris or grit
- Wastewater flow characteristics (e.g., flowing freely or backed up?)
- Infiltration including a flow estimate (note the presence of clear water in or flowing through the manhole)
- Presence of corrosion
- Offsets or misalignments
- Condition of the frame
- Evidence of surcharge
- Atmospheric hazard measurements (especially hydrogen sulfide)
- If repair is necessary, a notation as to whether a W.O. has been issued.

Manholes should undergo routine inspection typically every one to five years. There should be a baseline for manhole inspections, e.g., once every two years with problematic manholes being inspected more often. The auditor should conduct visual observation at a small but representative number of manholes for the items listed above.

2.4.3 Smoke Testing, Building Inspections and Dyed Water Flooding

Areas Likely to be Smoke Tested

- Drainage paths
- Ponding areas
- Roof leaders
- Cellars
- Yard and area drains
- Fountain drains
- Abandoned building sewers
- Faulty service connections.

Smoke testing is a relatively inexpensive and quick method of detecting I/I sources in sewer systems. It works best when used to detect cross connections and point source inflow leaks. Smoke testing is not used on a routine basis, rather it is used when evidence of excessive I&I already exists. Smoke testing is the filling of the sewers with smoke, such that the smoke exits through sewer connections. Sewer connections with properly water filled traps will not smoke. Traps are typically used on items such as sinks which must be connected to the sewer but need a trap to prevent sewer gas from entering the residence. Smoke testing provides positive proof of a building's non-trapped connections to the sewer. Non-trapped connections are typically downspouts, driveway drains and other connections where entry of sewer gas is not a concern and may be significant sources of inflow. Auditors should be aware that smoke testing is not effective at identifying RII when the soil over pipes is saturated, frozen, or snow covered. Two drawbacks of smoke testing are the negative findings do not necessarily prove that I/I problems do not exist and the smoke's exit point is not necessarily the point of inflow.

The authority should have a regular program of smoke testing. The program should include public notification procedures, frequency and schedule of smoke testing and procedures to record the results. The authority should have procedures which define how line segments are isolated, the maximum amount of line to be smoked at one time, weather conditions in which smoking is carried out (i.e., no rain, no snow, little wind, daylight only). The results of positive smoke tests should be documented with carefully labeled photographs. Written records should include the location/address along with a description of the smoking elements.

Building inspections are sometimes conducted as part of a smoke testing program. Building inspections are sometimes the only way to find illegal connections. However, since building inspections can be resource-intensive (on both staff and time), they are typically used only sparingly.

Dyed water testing is used to establish the connection of a fixture or appurtenance to the sewer. It is often used to confirm smoke testing or to test fixtures that did not smoke. As is the case with smoke testing it is not used on a routine basis but rather in areas that have displayed high wet weather flows. Dyed water testing can be used to identify structurally damaged manholes creating potential I/I problems. This is accomplished by flooding the area close to suspected manholes with dyed water and checking for entry of dyed water at the frame-chimney area, cone/corbel, and walls of the manhole. The auditor should review the utility's procedures on dyed water testing and the dye testing records.

2.4.4 Closed Circuit Television

Possible Defects Determined by TV Inspection

- House connection leaks
- Infiltration points
- Pipe corrosion
- Broken pipes
- Crushed pipes
- Collapsed pipes
- Offset joints
- Root intrusions.

Closed Circuit Television (CCTV) inspections are an essential tool for early detection of potential problems. CCTV inspections should be done on a routine basis as part of the preventative maintenance program as well as part of an investigation into the cause of I&I. CCTV provides the most complete picture of the structural condition of the pipe that can be obtained short of actually walking through pipes of very large diameter. CCTV however, eliminates the hazards associated with confined space entry. Television inspection is accomplished by passing a camera, specifically designed for sewer inspection, through the sewer. The output is displayed on a monitor and a tape is made of the proceedings. An additional benefit of TV inspection is that a permanent visual record is maintained for subsequent reviews.

The authority should have in place a program for CCTVing. The program should include frequency and schedule of CCTVing and procedures to record the results. The program should be in place whether the utility does their own CCTV or contracts it out. Sewer system cleaning should always be considered *before* TV inspection in order to provide adequate clearance and inspection results. Most records maintained for CCTV activities are maintained on standard logs. The logs should include:

- Location and identification of line being televised by terminus manholes.
- Pipe size and type.
- CCTV operator name.
- Distance CCTVed
- Cleanliness of the line
- Condition of the manhole with pipe defects identified by footage from the starting manhole
- Results of CCTV, including estimates of I/I.

It should be noted that CCTV results are often in code. The authority should be able to produce an explanation of the code. Auditors should note that for each pipeline inspected the videotape should contain the entire pipeline, regardless of its condition, to ensure the work was completed. Operational procedures and guidelines should accompany any CCTV program.

2.4.5 Rehabilitation

The collection system authority should have in place a program for sewer rehabilitation. The objective of sewer rehabilitation is to maintain the overall viability of a conveyance system. This is done in three ways: (1) by ensuring its structural integrity, (2) limiting the loss of conveyance and wastewater treatment capacity through reducing infiltration and inflow (I/I), and (3) limiting the potential for groundwater contamination through controlling exfiltration from the pipe network. The rehabilitation program should build on information obtained as a result of all forms of maintenance and observations made as part of the capacity evaluation. It is important that the auditor gain a sense of how rehabilitation is prioritorized. This may be stated in the written program or may be obtained through interviews with authority personnel.

There are many rehabilitation methods. The choice of methods will depend on pipe size, type, location, dimensional changes, sewer flow, material deposition, surface conditions, severity of I/I and other physical factors. Non-structural repairs typically involve the sealing of leaking joints in otherwise sound pipe. Pull-through packer systems are used to test (using air pressure), inject a variety of chemical grouts into leaking joints, and then retest sealed joints, all without excavation. Elastomer sealing rings may also be placed (typically in larger pipes) to seal joints. Specialized equipment is also used to seal leaking joints in service laterals and at the point of connection of those laterals to the sewer main.

Structural repairs involve either the replacement of all or a portion of a sewer line, or the lining of the sewer. These repairs can be carried out by excavating (common for repairs limited to one or two pipe segments; these are known as point repairs) or by trenchless technologies (in which repair is carried out via existing manholes or a limited number of access excavations). These include slip lining (in which a smooth plastic liner is pulled through the pipe), cured-in-place-pipe (CIPP) technologies (in which a resin-soaked felt liner is "inverted" into the pipe and cured in place), and fold-and-form technologies (in which a heated plastic liner is folded, pulled into place, and then expanded and allowed to harden). A variation of slip lining is pipe bursting, in which a bursting head is pulled through the existing pipe, bursting it, and at the same time pulling a continuous replacement pipe through the resulting "hole in the ground". These technologies all create a smooth, continuous, and generally leak-free "pipe-within-a-pipe".

The rehabilitation program should identify the methods that have been used in the past, their success rating and methods to be used in the future. An auditor who wants further guidance on methods of rehabilitation may consult:

- "Operation and Maintenance of Wastewater Collection Systems", California State University, Sacramento
- Existing Sewer Evaluation and Rehabilitation, WEF MOP FD-6, 1994.

The auditor should determine the authority's position on the rehabilitation of service laterals. Service laterals can constitute a serious source of infiltration/inflow. Manholes should not be neglected in the rehabilitation program. Manhole covers can allow significant inflow to enter the system because they are often located in the path of surface runoff. Manholes themselves can also be a significant source of infiltration from cracks in the barrel.

The authority should be able to produce documentation on the location and methods used for sewer rehabilitation. The auditor should compare the rehabilitation accomplished with that recommended by the capacity evaluation program. Is rehabilitation taking place before it becomes emergency maintenance? Are recommendations made as a result of the inspections previously described being carried out? Does the rehabilitation program take into account the age and condition of the sewers?

CHAPTER 3. CHECKLIST FOR CONDUCTING EVALUATIONS OF WASTEWATER COLLECTION SYSTEM CAPACITY, MANAGEMENT, OPERATION AND MAINTENANCE (CMOM) PROGRAMS

The following is a comprehensive checklist to be used by the inspector in the evaluation process. It is comprised of a series of questions organized by major categories and sub-categories. The major category is followed by a brief statement describing the category. Following the sub-category is a brief clarifying statement. References are then given.

Questions are provided in a table format that includes the question, Response, and Documentation Available.

Response is completed by using information and data acquired from the data and information request, onsite interviews, and inspections. An alternative to this process is to transmit the entire checklist to the utility and have them complete and return it electronically.

Table of Contents

I. General Information

Question	Response	Documentation Available	
		Yes	No
Size of service area (acres).			
Population of service area.			
Number of pump stations.			
Feet (or miles) of sewer.			
Age of system.			

Comments:

II. Continuing Sewer Assessment Plan

Question	Response	Documentation Available	
		Yes	No
Does the utility experience problems related to I&I? How do these problems manifest themselves? (Manhole overflows, basement flooding, structure, SSOs)			
How does the utility prioritize investigation, repairs and rehabilitation related to I & I?			
What methods are considered to remedy hydraulic deficiencies?			
Does the plan include a schedule for investigative activities?			
Is the plan regularly updated?			

Comments:

III. A. Collection System Management: Organizational Structure

Question	Response	Documentation Available	
		Yes	No
Is an organizational chart available that shows the overall organizational structure of the utility?			
Are there organizational charts that show functional groups and classifications?			
Are up to date job descriptions available?			
Does the organizational chart indicate how many positions are budgeted as opposed to actually filled?			
Are collection system staff responsible for any other duties, (e.g., road repair or maintenance, O&M of the storm water collection system)?			

Comments:

III. B. Collection System Management: Training

Question	Response	Documentation Available	
		Yes	No
Is there a documented formal training program?			
Does the training program include a general training program to address the fundamental mission, goals, and policies of the collection system utility?			
Does the training program include specialized technical training to address the methods, procedures, etc. required to perform the duties and tasks necessary for collection system operation and maintenance?			
Do these programs have formal curriculums?			
Does On-the-Job (OJT) training use Standard Operating and Standard Maintenance Procedures (SOPs & SMPs)?			
Is OJT progress and performance measured?			
Are operator and maintenance certification programs used?			
If yes, describe certification programs.			
Does the utility have a system to track employee training?			

III. C. Collection System Management: Communication and Customer Service

Question	Response	Documentation Available	
		Yes	No
What type of public education/outreach programs does the utility have about user rates?			
Do these programs include communication with groups such as local governments, community groups, the media, schools, youth organizations, senior citizens?			
Is there a public relations program in place?			
Are the employees of the utility trained in public relations?			
Is the public notified prior to major construction or maintenance work?			
How often does the utility communicate with other municipal departments?			
How are public complaints, regarding the collection system, handled?			
What are the common complaints received?			
What percentage of complaints are the utility's responsibility?			
How often are these complaints reported? Is there a record?			
Does the utility have a formal procedure in place to evaluate and respond to complaints?			
Does the utility have a process for customer evaluation of the services provided?			
How are complaint records maintained? (i.e., computerized) Is this information used as the basis for other activities such as routine preventative maintenance?			

Comments:

III. D. Collection System Management: Management Information Systems

Question	Response	Documentation Available	
		Yes	No
What types of work reports are prepared by the O&M Staff?			
Do the work reports include enough information? (See example report forms)			
How are records kept?			
Does the utility use computer technology for its management information system? (Computer Based Maintenance Management Systems, spreadsheets, data bases, SCADA, etc). If so, what type of system(s) does the utility use?			
What kind of reports are generated from work report data?			

Comments:

III. E. Collection System Management: SSO Notification Program

Question	Response	Documentation Available	
		Yes	No
Does the utility have standard procedures for notifying state agencies, health agencies, the NPDES authority, and the drinking water purveyor of overflow events?			
Are above notification procedures dependent on the size or location of the overflow? If so, describe this procedure.			
Is there a Standard form for recording overflow events? Does it include location, type, receiving water, estimated volume, cause?			
Chronic SSO locations posted?			

Comments:

III. F. Collection System Management: Legal Authority

Question	Response	Documentation Available	
		Yes	No
What types of legal documents, sewer use ordinance, service agreements, contracts, does the agency use to control discharges to the system?			
Does the agency use satellite collection systems agreements? Are the agreements easily modified? Flow based? Contain MOM provisions?			
Does the agency maintain the legal authority to control inflow sources?			

Comments:

IV. A. Collection System Operation: Budgeting

Question	Response	Documentation Available	
		Yes	No
What are the utility's current rates?			
How are user rates calculated?			
How often are user charges evaluated and adjusted based on that evaluation?			
How many rate changes have there been in the last 10 years and what were they?			
Does the utility receive sufficient funding from its revenues?			
Are utility enterprise funds used for non-enterprise fund activities?			
Does the utility budget for annual operating costs?			
Does the budget provide sufficient line item detail for labor, materials and equipment?			
Are detailed costs tracked for core and non-core business services delivered?			
Are costs for collection system O&M separated from other utility services, i.e., water, storm water and treatment plants?			
Do O&M managers have current O&M budget data?			
Are O&M staff involved in O&M budget preparation?			
How are priorities determined for budgeting for O&M during the budget process?			
Does the utility maintain a fund for future equipment and infrastructure replacement?			
Does the operating budget provide for sufficient funding to support an adequate O&M program?			
How is new work typically financed?			

Comments:

IV. B. Collection System Operation: Compliance

Question	Response	Documentation Available	
		Yes	No
Does the utility have inter-jurisdictional or inter-municipal agreements?			
Is there a sewer-use and a grease ordinance?			
Is there a process in place for enforcing sewer and grease ordinances?			
Are all grease traps inspected regularly?			
How does the utility learn of new or existing unknown grease traps?			
Who is responsible for enforcing the sewer ordinance and grease ordinance? Does this party communicate with the utility department on a regular basis?			
Are there any significant industrial dischargers to the system?			
Is there a pretreatment program in place? If so, please describe.			
Is there an ordinance dealing with private service laterals?			
Is there an ordinance dealing with storm water connections or requirements to remove storm water connections?			

IV. C. Collection System Operation: Water Quality Monitoring

Question	Response	Documentation Available	
		Yes	No
Is there a water quality monitoring program in the service areas?			
How many locations are monitored?			
What parameters are monitored and how often?			
Is water quality monitored after an SSO event?			
Are there written standard sampling procedures available?			
Is analysis performed in-house or by a contract laboratory?			
Are chain-of-custody forms used?			

Comments:

IV. D. Collection System Operation: Hydrogen Sulfide Monitoring and Control

Question	Response	Documentation Available	
		Yes	No
Are odors a frequent source of complaints? How many?			
What is the typical sewer slope? Does the utility take hydrogen sulfide corrosion into consideration when designing sewers?			
Does the collection system utility have a hydrogen sulfide problem, and if so, does it have in place corrosion control programs?			
What are the major elements of the utility's program?			

Comments:

IV. E. Collection System Operation: Safety

Question	Response	Documentation Available	
		Yes	No
Is there a documented safety program supported by the top administration official?			
Is there a Safety Department that provides training, equipment, and an evaluation of procedures?			
Are all O&M staff required to follow safe work procedures, such as the use of personal protective equipment (PPE), confined spaces, lock out/tag out, trenching and shoring policies, etc. ?			
What type of safety equipment is available? (Tripod/hoist, atmospheric testing equipment, SCBA, lights and barricades, exhaust fans and personal protective gear?) Is the equipment maintained in a convenient location and in good condition?			
Is there a permit required confined space entry procedure for manholes, wetwells, etc.? Are confined spaces clearly marked?			
How often are safety procedures reviewed and revised?			
Are workplace accidents investigated?			
How does the Administration communicate with field personnel on safety procedures; memo, direct communication, video, etc.?			
Is there a Safety Committee with participation by O&M staff? How often does it meet?			
Is there a formal Safety Training Program? Are records of training maintained?			

Comments:

IV. F. Collection System Operation: Emergency Preparedness and Response

Question	Response	Documentation Available	
		Yes	No
Does the facility have an emergency response plan? A contingency plan?			
Does the plan take into consideration vulnerable points in the system, severe natural events, failure of critical system components, vandalism or other third party events, and a root cause analysis protocol?			
Are there emergency operation procedures for equipment and processes?			
How does the facility track and report emergencies?			
Is there an emergency contact list, including telephone numbers?			
Is there a hazard classification system? Where is it located?			
Does the facility conduct vulnerability analyses?			
Are staff trained and drilled to respond to emergency situations? Are responsibilities detailed for all personnel who respond to emergencies?			
Are risk assessments performed? How often?			
Do work crews have immediate access to tools and equipment during emergencies?			
Is there a public notification plan? If so, does it cover both regular business hours and off-hours?			

Comments:

IV. G. Collection System Operation: Modeling

Question	Response	Documentation Available	
		Yes	No
Does the utility have a hydraulic Model of the Collection system including pump stations? What model is used?			
What uses does the Model serve (predicting flow capacity, peak flows, force main pressures, etc.)?			
Is the model calibrated? How? How often?			
Is the model kept up to date with respect to new construction and repairs that may affect hydraulic capacity?			

Comments:

IV. H. Collection System Operation: Engineering- System Mapping and As-built Plans (Record Drawings)

Question	Response	Documentation Available	
		Yes	No
What type of mapping/inventory system is used?			
Is there a procedure for recording changes and for updating the mapping system?			
Are sewer and manhole attributes (size, material, age, slope, invert elevation, etc.) recorded?			
Are "as-built" plans (record drawings) or maps available for use by field crews in the office and in the field?			
Do field crews record changes or inaccuracies and is there a process in place to update "as built" plans (record drawings)?			
Is mapping information in a GIS?			

Comments:

IV. I. Collection System Operation: Engineering - Design

Question	Response	Documentation Available	
		Yes	No
Is there a document which details design criteria and standard construction details?			
Is life cycle cost analysis performed as part of the design process?			
Is there a document that describes the procedures that the utility follows in conducting design review? Are there any standard forms that guide the utility?			
Are O&M staff involved in the design review process?			
Do design documents have established protocol for start-up, testing and acceptance?			

Comments:

IV. J. Collection System Operation: Engineering - Capacity

Question	Response	Documentation Available	
		Yes	No
What procedures are used in determining whether the capacity of existing gravity sewer system, pump stations and force mains are adequate for new connections?			
Is any metering of flow performed prior to allowing new connections?			
Is there a hydraulic model of the system used to predict the effects of new connections?			
Is there any certification as to the adequacy of the sewer system to carry additional flow from new connections required?			

Comments:

IV. K. Collection System Operation: Engineering - Construction

Question	Response	Documentation Available	
		Yes	No
Who constructs new sewers? If other than the utility, does the utility review and approve the design?			
Is there a document that describes the procedures that the utility follows in conducting their construction inspection and testing program?			
Are there any standard forms that guide the utility in conducting their construction inspection and testing program?			
Is new construction inspected by the utility or others?			
What are the qualifications of the inspector(s)?			
What percentage of time is a construction inspector on site?			
Is inspection supervision provided by a registered professional engineer?			
How is the new gravity sewer construction tested? (Air, water, weirs, etc.)			
Are new manholes tested for inflow and infiltration?			
Are new gravity sewers televised?			
What tests are performed on pump stations?			
What tests are performed on force mains?			
Is new construction built to standard specifications established by the local utility and/or the State?			
Is there a warranty for new construction? If so, is there a warranty inspection done at the end of this period?			

Comments:

IV. L. Collection System Operation: Pump Station Operation

Question	Response	Documentation Available	
		Yes	No
How many pump stations are in the system?			
How many personnel are assigned to pump station operations?			
Are these personnel assigned full-time or part-time to pump station duties?			
Are there manned and un-manned pump stations in the system? How many of each?			
Are pump stations typically operated with one or more pumps on standby?			
What set points are established to turn the pumps on and off?			
How many times per hour do the pumps(s) typically cycle on and off?			

Comments:

IV. L. 1. Collection System Operation: Pump Stations - Inspection

Question	Response	Documentation Available	
		Yes	No
How often are pump stations inspected?			
What work is accomplished during inspections?			
Is there a checklist?			
Are there Standard Operating Procedures (SOPs) and Standard Maintenance Procedures (SMPs) for each station?			
What are the critical operating characteristics maintained for each station? Are the stations maintained within these criteria?			

Comments:

IV. L. 2. Collection System Operation: Pump Stations - Emergencies

Question	Response	Documentation Available	
		Yes	No
Is there an Emergency Operating Procedure for each pump station?			
Is there sufficient redundancy of equipment in all pump stations?			
Who responds to lift station failures and overflows? How are they notified?			
How is loss of power at a station dealt with? (i.e. on-site electrical generators, alternate power source, portable electric generator(s))			
What equipment is available for pump station bypass?			
What process is used to investigate the cause of pump station failure and take necessary action to prevent future failures?			

Comments:

IV. L. 3. Collection System Operation: Pump Stations - Emergency Response and Monitoring

Question	Response	Documentation Available	
		Yes	No
How are lift stations monitored?			
If a SCADA system is used, what parameters are monitored?			

Comments:

IV. L. 4. Collection System Operation: Pump Stations - Recordkeeping

Question	Response	Documentation Available	
		Yes	No
Are operations logs maintained for all pump stations?			
Are manufacturer's specifications and equipment manuals available for all equipment?			
Are pump run times maintained for all pumps?			
Are elapsed time meters used to assess performance?			

Comments:

IV. L. 5. Collection System Operation: Pump Stations - Force Mains and Air/Vacuum Valves

Question	Response	Documentation Available	
		Yes	No
Does the utility regularly inspect the route of force mains?			
Does the utility have a program to regularly assess force main condition?			
Is there a process in place to investigate the cause of force main failures?			
Does the utility have a regular maintenance/inspection program for air/vacuum valves?			
Have force main failures been caused by water hammer?			

Comments:

V. A. Collection System Maintenance: Maintenance Budgeting

Question	Response	Documentation Available	
		Yes	No
How does the collection system utility track yearly maintenance costs?			
Is there a maintenance cost control system?			
Are maintenance costs developed from past cost records?			
How does the utility categorize costs? Preventive? Corrective? Projected Costs? Projected Repair?			
How does the utility control expenditures?			

V. B. Collection System Maintenance: Planned Maintenance

Question	Response	Documentation Available	
		Yes	No
Are preventive maintenance tasks and frequencies established for all pump stations and equipment?			
How were preventative maintenance frequencies established?			
What percentage of the operator's time is devoted to planned as opposed to unplanned maintenance?			
What predictive maintenance techniques are used as part of PM program?			
Is there a formal procedure to repair or replace pump stations and equipment when useful life is reached?			
Has an energy audit been performed on pump station electrical usage?			
Is an adequate parts inventory maintained for all equipment?			
Is there a sufficient number of trained personnel to properly maintain all stations?			
Who performs mechanical and electrical maintenance?			
Are there Standard Maintenance Procedures (SMPs) for each station?			

Comments:

V. C. Collection System Maintenance: Maintenance Scheduling

Question	Response	Documentation Available	
		Yes	No
Does the utility plan and schedule preventive and corrective maintenance activities?			
Is there an established priority system? Who sets priorities for maintenance?			
Is maintenance backlog tracked?			
How is O&M performance tracked and measured?			
Is maintenance performed for other public works divisions?			
How are priorities determined for this work?			
How is this work funded?			
Are maintenance logs maintained for all pump stations?			

Comments:

V. D. Collection System Maintenance: Maintenance Right-of-Way

Question	Response	Documentation Available	
		Yes	No
Does the utility perform scheduled maintenance on Rights-of-Way and Easements?			
Does the utility monitor street paving projects?			
Does the utility have a program to locate and raise manholes (air valves, etc) as needed?			
How are priorities determined?			
How is the effectiveness of the maintenance schedule measured?			

Comments:

V. E. Collection System Maintenance: Sewer Cleaning

Question	Response	Documentation Available	
		Yes	No
Is there a routine schedule for cleaning sewer lines on a system wide basis, *e.g.*, at the rate of once every seven to twelve years or a rate of between 8% and 14% per year?			
Is there a program to identify sewer line segments that have chronic problems and should be cleaned on a more frequent schedule?			
Are stoppages diagnosed to determine the cause?			
Are stoppages plotted on maps and correlated with other data such as pipe size and material, or location?			

Comments:

V. E. 1. Collection System Maintenance: Sewer Cleaning - Cleaning Equipment

Question	Response	Documentation Available	
		Yes	No
What type of cleaning equipment does the collection system utility use?			
How many cleaning units of each type does the utility have? What is the age of each?			
How many cleaning crews and shifts does the utility employ?			
How many cleaning crews are dedicated to preventative maintenance cleaning?			
How many cleaning crews are dedicated to corrective maintenance cleaning?			
What has the utility's experience been regarding pipe damage caused by mechanical equipment?			
Where is the equipment stationed?			

Comments:

V. E. 2. Collection System Maintenance: Sewer Cleaning - Chemical Cleaning and Root Removal

Question	Response	Documentation Available	
		Yes	No
Does the utility have a root control program?			
Are chemical cleaners used?			
What types of chemical cleaners are used?			
How often are they applied?			
How are the chemical cleaners applied?			
What results are achieved through the use of chemical cleaners?			

Comments:

V. F. Collection System Maintenance: Emergency Maintenance

Question	Response	Documentation Available	
		Yes	No
Is there an established written Emergency Response Plan?			
What type of emergency maintenance equipment does the utility have available?			
How quickly can the utility access that equipment in case of an emergency?			
Does the utility have procedures to minimize the volume of untreated wastewater transmitted to the affected portions of the collection system?			
Does the utility have a program to monitor water bodies affected by wastewater overflows?			
Does the utility have procedures to investigate the cause of a wastewater overflow?			
Does to utility have procedures to limit public access to and contact with areas affected by wastewater overflow?			
Does the utility have procedures to provide expedient public notice?			

V. G. Collection System Maintenance: Parts Inventory

Question	Response	Documentation Available	
		Yes	No
Does the utility have a central location for the storage of spare parts?			
Have critical spare parts been identified?			
Does the utility maintain a stock of spare parts on its maintenance vehicles?			
What method(s) does the utility employ to keep track of the location, usage, and ordering of spare parts? Are parts logged out when taken by maintenance personnel for use?			
Does the utility salvage specific equipment parts when equipment is placed out-of-service and not replaced?			
How often does the utility conduct a check of the inventory of parts to ensure that their tracking system is working?			
Who has the responsibility of tracking the inventory?			
What other procurement methods are available to O&M staff for non-stock materials?			

Comments:

V. H. Collection System Maintenance: Equipment and Tools Management

Question	Response	Documentation Available	
		Yes	No
Is there a list of equipment and tools used for operation and maintenance?			

Do personnel feel they have access to the necessary equipment and tools to do all aspects of operation and maintenance of the collection system?			
Is there access to suitable equipment if the utility's equipment is down for repair?			
Does the utility own or have access to portable generators?			
Where does the utility store its equipment?			
Is a detailed equipment maintenance log kept?			
Are written equipment maintenance procedures available?			
What is the procedure for equipment replacement?			
Are the services of an in-house vehicle and equipment maintenance services used?			
What is the typical turnaround time for equipment and vehicle maintenance?			

VI. A. 1. Management Information Systems: Performance Indicators

References:

Question	Response	Documentation Available	
		Yes	No
How many sanitary sewer overflows (SSOs) have occurred in the last year? Is there a record?			
Do SSOs occur from manholes, pump stations or structural bypasses?			
Are there areas that experience basement or street flooding?			
How many SSOs have reached "Waters of the US"? Is there a record?			
What is the per capita wastewater flow for the maximum month and maximum week or day?			
What is average annual influent BOD?			
What is the ratio of maximum wet weather flow to average dry weather flow?			
What is the annual number of overflows, and what is the cause (i.e. blockage, pump malfunction, overloaded sewer, construction damage, etc.)?			
What is the annual number of mainline sewer cave-ins? What was the cause (i.e. pipe corrosion, leaks, etc.)			
What other types of performance indicators does the utility use?			

VII. A. Sewer System Capacity Evaluation: Internal TV Inspection

Question	Response	Documentation Available	
		Yes	No
Does the utility use internal T.V. inspection? If so please describe the program.			
What percent of the system has been televised as part of the capacity evaluation? As part of the SSES?			
What defects were identified and how were they classified, i.e., structural, infiltration, lateral connections, an operational such as grease and roots?			
What follow-up actions were performed in response to deficiencies identified in TV inspections?			
Were operational defects used to establish PM tasks and frequencies?			

Comments:

VII. B. Sewer System Capacity Evaluation: Survey and Rehabilitation (general)

Question	Response	Documentation Available	
		Yes	No
Have SSES's been performed in the past? If so, is documentation available?			
Has any sewer rehabilitation work been done in the past 15 years? If so, please describe?			
Does the utility have standard procedures for performing SSES work?			
Do the SSES reports include recommendations for rehabilitation, replacement, and repair?			
Were defects identified in the SSES repaired?			
Does the utility have a multi-year Capital Improvements Program that includes rehabilitation, replacement, and repair?			
How are priorities established for rehabilitation, replacement, and repair?			
Has the utility established schedules for performing recommended rehabilitation, both short term and long term?			
Has funding been approved for the recommended rehabilitation?			
Is post rehabilitation flow monitoring used to assess the success of the rehabilitation?			

Comments:

VII. C. Sewer System Capacity Evaluation: Sewer Cleaning Related to I/I Reduction

Question	Response	Documentation Available	
		Yes	No
Are sewers cleaned prior to flow monitoring?			
Are sewers cleaned prior to internal T.V. inspection?			
When cleaning, is debris removed from the system?			

Comments:

VII. D. Sewer System Capacity Evaluation: Flow Monitoring

Question	Response	Documentation Available	
		Yes	No
Does the utility have a flow monitoring program? If so, please describe.			
Number of permanent meters? Number of temporary meters?			
What type(s) of meters are used?			
Number of rain gauges?			
How is flow data used?			

Comments:

VII. E. Sewer System Capacity Evaluation: Smoke Testing and Dyed Water Flooding

Question	Response	Documentation Available	
		Yes	No
Does the utility have a smoke testing program to identify sources of inflow and infiltration into the system? If so please describe. Is the program routine of only emergency?			
Does the utility have a dyed water flooding program to identify suspected sources (indirect connections) of inflow and infiltration into the system when smoke testing yields inconclusive results? If so please describe.			
What follow-up occurs as a result of positive results for smoke or dye testing?			
Is there a data management system for tracking these activities?			
Is there a document that describes the procedures that the utility follows? Are there any standard forms?			
What percent of the system has been smoke tested to date as part of the capacity evaluation? As part of the SSES?			

Comments:

VII. F. Sewer System Capacity Evaluation: Manhole Inspection

Question	Response	Documentation Available	
		Yes	No
Does the utility have a routine manhole inspection and assessment program?			
What is the purpose of the inspection program?			
Are manholes susceptible to inflow identified and inspected on a regular frequency?			
Is there a data management system for tracking manhole inspection activities?			
What triggers whether a manhole needs rehabilitation?			
Does the utility have a multi-year Capital Improvements Program that includes rehabilitation, replacement, and repair of manholes?			
How are priorities established for rehabilitation, replacement, and repair of manholes?			
Has the utility established schedules for performing rehabilitation, both short term and long term of manholes?			
Has funding been approved for the rehabilitation of manholes?			

Comments:

VIII. A. Rehabilitation: Manhole Repairs

Question	Response	Documentation Available	
		Yes	No
What rehabilitation techniques are used for manhole repairs?			
How are priorities determined for manhole repairs?			
What type of documentation is kept?			
Does the utility use manhole inserts?			
Are they used system wide or only on low lying manholes?			

Comments:

VIII. B. Rehabilitation: Mainline Sewers

Question	Response	Documentation Available	
		Yes	No
What type of main line repairs has the utility used in the past?			
Does the utility currently use any of above techniques for main line repairs? What other techniques is the utility presently using?			
How are priorities established for main line repairs?			
What type of follow-up is performed after the repair (e.g., CCTV)?			

Comments:

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APPENDIX A
COLLECTION SYSTEM PERFORMANCE INDICATOR DATA COLLECTION FORM

I. General Information

A. Agency Name ____

B. Agency Address
Street ____
City ____________________________ State ____________________________
Zip __________ C. Contact Person ____
D. Telephone: Voice __________________ Fax ____________________
E-Mail _____________

E. Data provided for latest fiscal/calendar year, 19 ____

II. Collection System Description

A. Service Area _____________ Square miles

- Population Served ____________________
- System Inventory

Miles of gravity sewer	Miles of force main	Number of maintenance access structures	Number of pump stations	Number of siphons	Number of air, vacuum, or air/vacuum relief valves

D. Number of Service Connections:
Residential ________ Commercial ________ Industrial ________ Total _______

E. Lateral Responsibility (check one)
1. At main line connection only ____________
2. From main line to property line or easement/cleanout ____________
3. Beyond property line/cleanout _____________
4. Other ___________

F. System combined (storm and sanitary)? Yes ____ No ____ If yes, % combined _____

G. Average Annual Precipitation _____________ inches

H. System Flow Characteristics (total for service area)

Peak Dry Weather Flow (MGD)	Peak Wet Weather Flow (MGD)	Average Daily Flow (MGD)

III. Special Conditions

A. Indicate local conditions that are accounted for during design, construction, operation, and maintenance of the collection system.

- **Precipitation: Yes _____ No ______ If yes, provide brief explanation ______**

  ____

  ____

- **Terrain: Yes _____ No ______ If yes, provide brief explanation ____ _______**

  ____

  ____

- **Soils: Yes _____ No ______ If yes, provide brief explanation ______ _______**

  ____

  ____

4. **Temperature: Yes _____ No ______ If yes, provide brief explanation ______**

   ____

   ____

5. **Groundwater: Yes ______ No ______ If yes, provide brief explanation ______**

   ____

   ____

6. **Geology: Yes _____ No ______ If yes, provide brief explanation ____ ______**

   ____

   ____

7. **Other: ____ ______________**

   ____

   ____

B. Is corrosion a significant problem? Yes ____ No ____ _

1. Is there a corrosion control program in place? Yes ____ No _____

C. Is odor a significant problem? Yes ____ No _____

1. Is there an odor control program in place? Yes ____ No ____ _

- **Is grease a significant problem? Yes ____ No ____ _**

1. Is there a grease control program in place? Yes ____ No ____
_

E. Are roots a significant problem? Yes ____ No ____
_

1. Is there a root control program in place? Yes ____ No _____

IV. Age Distribution of Collection System

Age	Gravity Sewer, miles	Force Mains, miles or feet	Number of Pump Stations
0 - 25 years			
26 - 50 years			
51 - 75 years			
> 76 years			

V. Size Distribution of Collection System

Diameter in inches	Gravity Sewer, miles	Force Mains, miles or feet
8 inches or less		
9 - 18 inches		
19 - 36 inches		
> 36 inches		

VI. Distribution of Gravity Sewer By Material

A. Vitrified Clay Pipe (VCP) ____________ Miles
B. Reinforced Concrete Pipe (RCP) ____________ Miles
C. Unreinforced Concrete Pipe (CP) ____________ Miles
D. Plastic (all types) ____________ Miles
E. Brick ____________ Miles
F. Other ____________ Miles
G. Other ____________ Miles
H. Other ____________ Miles

VII. Distribution of Force Mains By Material

(circle one)

A. Reinforced Concrete Pipe (RCP) ____________ miles or feet
B. Prestressed Concrete Cylinder Pipe (PCCP) ____________ miles or feet
C. Asbestos Cement Pipe (ACP) ____________ miles or feet
D. Polyvinyl Chloride (PVC) ____________ miles or feet
E. Steel ____________ miles or feet
F. Ductile Iron ____________ miles or feet
G. Cast Iron ____________ miles or feet
H. Techite (RPMP) ____________ miles or feet
I. High Density Polyethylene (HDPE) ____________ miles or feet
J. Fiberglass Reinforced Plastic (FRP) ____________ miles or feet

K. Other ____________ **miles or feet**

VIII. Preventive Maintenance of System

A. Physical Inspection of Collection System, Preventive Maintenance

Inspection Activity	Total Annual Labor Hours Expended for This Activity	Total Completed (Miles of Pipe or Manholes Inspected Annually)	Crew Size (s)
CCTV			
Visual Manhole Inspection, Surface Only			
Visual Manhole Inspection, Remove Cover			
Visual Gravity Line Inspection, Surface Only			
Visual Force Main Inspection, Surface Only			
Other (Sonar, etc.)			

B. Mechanical and Hydraulic Cleaning, Preventive Maintenance

Cleaning Activity	Total Annual Labor Hours Expended for This Activity	Total Annual Labor Hours Expended for Scheduled PM	Total Miles Cleaned Annually	Crew Size (s)	Range of Pipe Diameters Cleaned
Hydraulic Jet					
Bails, Kites, Scooters					
Combination Machines					
Rod Machines					
Hand Rodding					
Bucket Machines					

Chemical Root Control					
Chemical or Biological Grease Control					

IX. Dry Weather Stoppages

A. Number of stoppages, annually _____________
B. Average time to clear stoppage _____________
C. Number of stoppages resulting in overflows and/or backups annually _____________
D. Total quantity of overflow(s) _____________
E. Is there an established procedure for problem diagnosis? Yes _____ No _____
F. Are future preventive measures initiated based on diagnosis? Yes _____ No _____
G. What equipment is available for emergency response? ___________________________

X. Repairs and Rehabilitation, Proactive

A. Number of annual spot repairs identified __________
B. Number of annual spot repairs completed _________
C. Percent of spot repairs contracted _______________
D. Number of manholes identified for rehabilitation __________
E. Number of manholes rehabilitated annually ___________
F. Percent of manhole repairs contracted ___________
G. Feet of main line needing rehabilitation __________
H. Feet of main line rehabilitated ________________
I. Percent of main line rehabilitation contracted _____________
J. Number of manholes scheduled for rehabilitation under Capital Improvement Program (s)______
K. Feet of main line scheduled for rehabilitation under Capital Improvement Program (s) __________

XI. Repairs and Rehabilitation, Reactive

A. Number of annual line features ___________
B. Number of line repairs __________

XII. Pump Stations

A. Number of pump stations inspected _______
   1. Frequency of inspections ____________ (daily, every other day, weekly)
B. Number of inspection crews ____________
C. Crew size __________
D. Number of pump stations with pump capacity redundancy ____________
E. Number of pump stations with backup power sources _____________
F. Number of pump stations with dry weather capacity limitations __________
G. Number of pump stations with wet weather capacity limitations __________
H. Number of pump stations calibrated annually _______________
I. Number of pump stations with permanent flowmeters ___________
J. Number of pump stations with remote status monitoring ___________
K. Number of pump stations with running time meters ____________
L. Number of mechanical maintenance staff assigned to mechanical maintenance _______
M. Number of electrical maintenance staff assigned to electrical maintenance __________
N. Total labor hours scheduled annually for electrical and mechanical PM tasks ________

O. Total labor hours expended annually for electrical and mechanical PM tasks ________

XIII. Pump Station Failures, Dry Weather

A. Number of failures resulting in overflows/bypass or backup, annually ______________

B. Total quantity of overflow/bypass ______ Gallons or MG

C. Average time to restore operational capability _______ hours

D. Total labor hours expended for electrical and mechanical corrective maintenance tasks _________

E. Is failure mode and effect diagnosed? Yes ___ No ___

F. Are future preventive measures initiated based on diagnosis? Yes ___ No ___

G. What equipment is available for emergency response? ___________________________ _________

XIV. Force Mains

A. Force mains inspected annually ____________ miles or feet (visual surface inspection of alignment)

B. Force mains monitored annually ___________ miles or feet (pressure profile, capacity)

C. Number of force main failures annually _____________

D. Cause(s) of force main failures ____

XV. Air Relief/Vacuum Valves

A. What is frequency of valve inspections? ________________________________

B. What is frequency of PM (backflushing, etc)? ________________________________

C. Number of annual valve failures _______________________

D. Cause(s) of valve failures ____

XVI. System Operation and Maintenance Efficiency

A. Total full time or full time equivalent staff assigned to O & M (excluding administration staff but including line managers, supervisors) __________________________

B. Total estimated labor hours actually expended for active O & M tasks (this is the total above less hours for sick, vacation, holidays, training, breaks, etc., not directly related to performing O & M tasks) __________________

XVII. Level of Service

A. Average annual rate for residential users _____________________

B. Rate based on: water consumption ___________ Flat rate _____________ Other _______________

C. Number of complaints annually _______________

D. Number of complaints that are agency responsibility _________________

E. Number of public health or other warnings issued annually _________________

F. Number of claims for damages due to backups annually __________________

G. Total cost of claims settled annually _______________

XVIII. Financial

A. Total annual revenue received from wastewater _____________________

1. % of revenue for long-term debt ____________________
2. % of revenue for treatment and disposal ______________
3. % of revenue for collection and conveyance ______________

B. Current value of collection system assets __________________________

C. Annual O & M expenditure _____________________

D. Annual CIP expenditure for repair, replacement, or rehabilitation ___________________________

E. Annual O & M training budget ______________________________

F. Total number of O & M personnel (including administrative in O & M department) ____ ________

G. Number of personnel with collection system certification ________________

H. Number of personnel qualified for collection system certification __________________

I. Amount of O & M budget allocated for contracted services _____________________

J. Hydroflush cost per foot ________________________

K. Rodding cost per foot ____________________

L. Bucketing cost per foot ___________________

M. CCTV cost per foot _______________________

N. Spot repairs, cost each __________________________

XIX. Safety

A. Total labor hours assigned to O & M ___________________
B. Number of lost time injuries ___________________
C. Total lost time days _______________
D. Total cost of lost time injuries _____________________

XX. Regulatory

A. Total number of violations issued annually ______________
B. Total cost of fines paid annually ________________
C. What is minimum reportable quantity in gallons? ________________
D. What is time reporting requirement? ____________________
E. Number of annual WWTP upsets due to wet weather flow _____________________

XXI. General

A. Has SSES been performed on system? Yes _______ No _______
B. Total O & M positions currently budgeted ___________________
C. Total O & M positions currently filled ______________________
D. Is computerized maintenance management system (s) used for O & M managing? Yes _______ No _______
E. Is GIS system used for O & M managing? Yes _______ No _______

XXII. Procedures or Other Documentation Available

A. Overflow, bypass and containment Yes _______ No _______
B. Problem evaluation and solution Yes _______ No _______
C. Cleanup procedure Yes _______ No _______
D. Failure mode and effect procedure Yes _______ No _______
E. O & M budget process Yes _______ No _______
F. O & M budget with line item detail Yes _______ No _______
G. Long-range CIP planning for system expansion, rehabilitation, and replacement Yes ___ No ____
H. Is there a written procedure for cleanup to mitigate effect of overflow? Yes _______ No _______
I. Is there a written procedure for containing overflows and bypasses? Yes _______ No _______
J. Is there an established procedure for containing overflows and bypasses? Yes ______ No _______
K. Is there an established procedure for problem evaluation and solution? Yes _______ No _______
L. Is there an established procedure for cleanup to mitigate effect of overflow? Yes _____ No ______
M. Is there a grease control program? Yes _______ No _______
N. Is there a pretreatment program? Yes _______ No _______
O. Is there a private source I/I reduction program? Yes _______ No _______
P. Do you have chronic O & M problems that are designed into your system? Yes ______ No ______
If yes, provide brief description ____

Q. Do you have chronic O & M problems that are constructed into your system? Yes ____ No _____If yes, provide brief description ____ ____________________

R. How would you rate your construction inspection program?
Very effective __________ Needs improvement __________ Poor ____________

XXIII. Definitions/Clarifications

A. Maintenance access structures, most commonly manholes, in your system that are incorporated into your O & M program.

B. Pump capacity redundancy is the ability to maintain pumping at design capacity with the largest pump out of service.

C. Remote status monitoring is any remote monitoring system such as alarm telemetry or SCADA that provides remote pump station status information.

D. You will notice that in the section on stoppages and pump station failures, we are asking for dry weather incidents only. Dry weather system performance is a good indicator or effectiveness of O & M program. If you have wet weather information that you wish to provide also, please do.

E. Under the Special Conditions sections we are identifying conditions that are present in your system that require consideration during design, construction, and O & M of your system.

F. Any of the questions dealing with labor hours are designed to determine total labor hours irrespective of crew size or crews that are only assigned to cleaning, for example, less than full time.

G. Our goal is to obtain data that can be or are standardized and that are accurate. We also realize that some data may not be available; however, data can be accurately estimated. If you estimate data please follow with an (E).

H. If data is not available please indicate “NA.” If data does not apply to your system, please indicate by “DNA.”

I. Failure mode and effect refers to any established procedure you have to diagnose system failures to determine the cause and effect of the failure. This can apply to crews clearing stoppages or to pump station failures.

J. Pump station inspection (XII) means scheduled inspection by operators to verify station operation and perform PM. It excludes electrical or mechanical craft maintenance.

K. Stoppage in section IX refers only to stoppages other than pump stations. Pump stations are covered in Section XIII. Backup in this case refers to a basement or other structure backup as opposed to main line sewer backup.

XXIV. Additional Comments